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MARKETING, NUTRITION AND ENGINEERING SCIENCES //

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ANNUAL REPORT OF THE  
NATIONAL RESEARCH PROGRAMS  
1977

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This publication reports research that frequently involves the use of agricultural chemicals. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.



## FORWARD

Research in Marketing, Nutrition and Engineering Sciences (MNES) extends and complements the continuum of research beyond that concerned with our soil, water and air resources, and with the production and protection of farm products. MNES research covers the complex marketing system from the farm to the consumer.

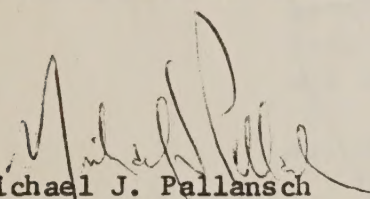
MNES research deals with safety of products and the manufacturing workplace, nutrition of our population and the world, development and efficient manufacture of products with optimum utility, quality and value, food protection, processing and preservation, transportation marketing and distribution, and utilization of agricultural fiber and other agricultural products and byproducts as raw material for conversion to industrial and consumer products. Through this research, competitiveness and efficiency of the marketing system is increased to the benefit of producers and consumers.

The knowledge gained is put into use by food, feed and fiber producers, educators and action and regulatory agencies, the food processing, marketing and distribution industries and the textile, leather and chemical industries.

The research workers in the Marketing, Nutrition and Engineering Sciences publish the results of their investigations in the open literature as quickly as sound scientific judgment warrants. The purpose of this report, however, is to provide for those interested in the fruits of this work, a brief overview of the scope of the activities and examples of recent findings, some of which still have not been released by publication. No attempt is made at completeness.

The report is organized by National Research Programs, each of which describes a separate subject-matter area. Some overlap of subjects is unavoidable.

Readers who have comment or inquiries are invited to contact either the National Program Staff, Building 005, BARC-West, Beltsville, Maryland 20705, or scientists at the locations where the research is conducted.



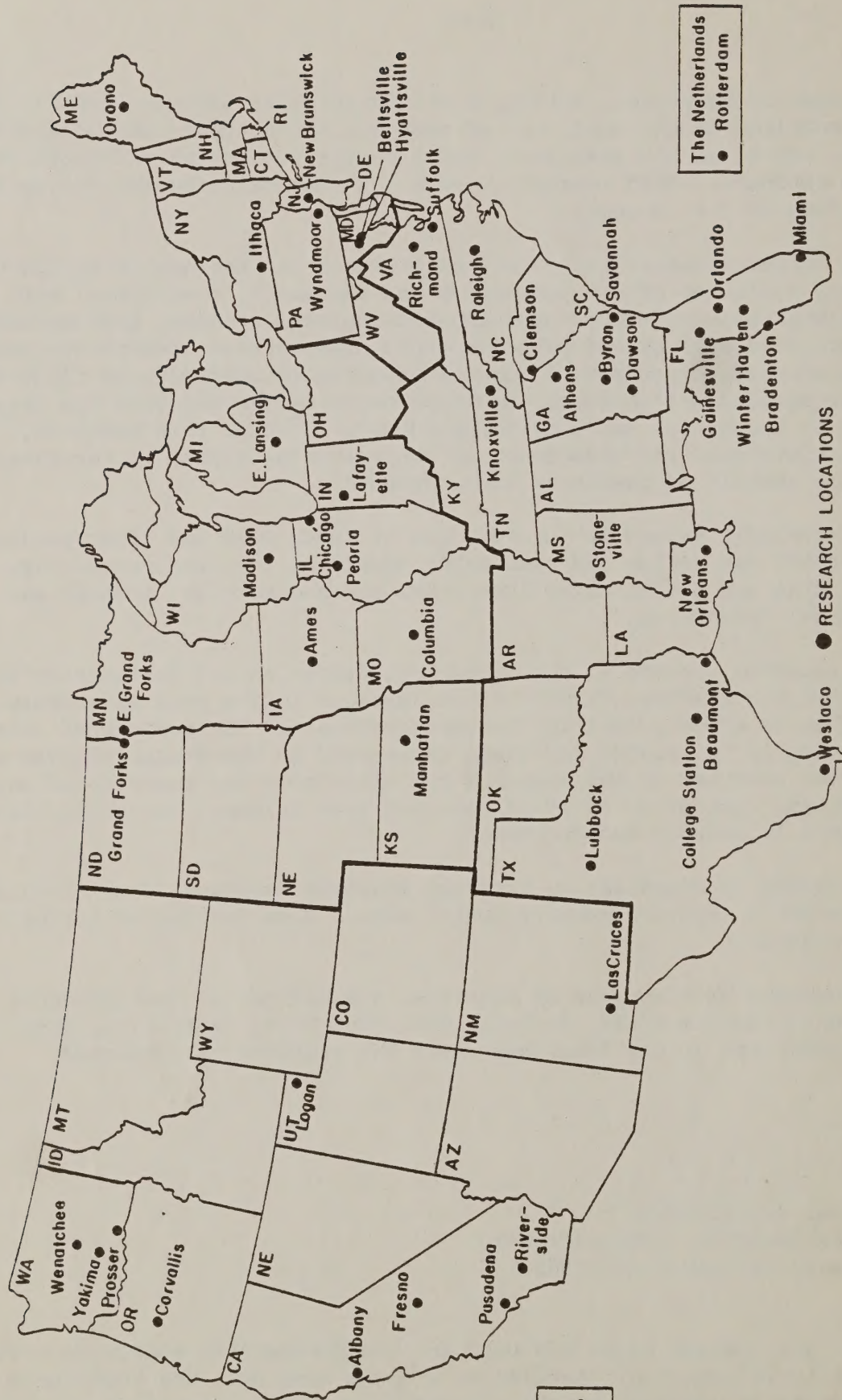
Michael J. Pallansch  
Acting Assistant Administrator  
National Program Staff, MNES

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The Netherlands  
● Rotterdam

● RESEARCH LOCATIONS

REGIONAL BOUNDARIES AND LOCATIONS OF MNES RESEARCH PERSONNEL

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## SUMMARY

Marketing, nutrition and engineering sciences research is the segment of the total SEA-FR program that is concerned with the storage, handling and conversion of raw agricultural commodities and livestock into commercial products and the marketing and delivery of these commodities and products to users and consumers through domestic and foreign trade channels.

This research is designed to maintain and improve the quality, safety, utility and value of the products to users and consumers, to increase utilization of agricultural products and to reduce costs through increased efficiency of the entire conversion, marketing and delivery system.

Research efforts are directed to the following areas: a) processing of fruits, vegetables, field crops, and animal products for food and feed uses, b) conversion and utilization of agricultural products and by-products for industrial and other nonfood uses, c) conversion of agricultural fibers to consumer products, d) storage, transportation and distribution of fruits, vegetables, seeds, nursery and floral products, field crops, livestock, meat and poultry products, e) protection of agricultural commodities and their products from losses to insects after harvest, f) quarantine treatments for prevention of movement in commerce of insect pests, g) development of new and improved products for export markets, h) transport and quality maintenance systems for overseas marketing, i) reducing hazards from chemical residues, additives, environmental contaminants, natural toxicants, and microorganisms and their toxins, j) development of data on use patterns for family resources, food usage and food consumption, k) determining human requirements for nutrients and the nutritional composition of foods, and l) increasing the nutrient content of foods through improved handling, storage, processing, formulation, and/or nutrient fortification.

The research is described under 19 National Research Programs (NRP's).

Recent activities and accomplishments are summarized in the following statements under each NRP.

NRP 20510 Technologies for Food and Feed Uses - Fruits & Vegetables

The two components of the spread between farm value and retail cost that are addressable by research under this NRP are product quality and processing efficiency. Quality is a major determinant of market demand and value and is composed of several factors--sensory (aroma, color, flavor, texture), nutrition and safety. Basic research is therefore conducted to elucidate: a) the identity of the compositional determinants of quality in processed products, b) the degree of variation of these determinants due to production and cultural practices, varietal differences, harvesting, handling, storage and processing, c) the mechanisms controlling these variations (chemical, physical, biochemical and biological), and d)

the analytical methodology required for measuring and characterizing these changes. The information developed provides guidance for the grower and the plant breeder, for preservation of postharvest quality and for development of processing procedures and new products that optimize these quality characteristics.

Much of this same information along with information on fruit and vegetable microstructure, physical constants, and engineering principles governing unit operations is pertinent also to processing efficiency. Improvement in the processing efficiency of fruits and vegetables, particularly in terms of energy, water, food loss, waste effluents, and yield of acceptable products is a subject of emphasis in current research.

#### NRP 20520 - Processing Technologies - Field Crops

This National Research Program deals with the spectrum of research problems involved in assuring the consumer an adequate supply of high quality, nutritious, safe and reasonably priced food and feed products from field crops and assuring the farmer a reasonable return for his crop. Oilseeds account for 36 percent of the \$10.1 million FY 1977 budget, with 31 percent in grains, 12 percent in sugar crops and 21 percent in forage and crop residues. Eighty-six percent of the budgeted program was conducted at three regional research centers. Oilseed research is conducted primarily at the Richard Russell Research Center (RRRC) in Athens, GA., the Northern Regional Research Center (NRRC) in Peoria, IL., and the Southern Regional Research Center (SRRC) in New Orleans, LA. Grain research is conducted at the Western Regional Research Center (WRRRC), Albany, CA., NRRC and SRRC; sugar crops at NRRC, SRRC, the Eastern Regional Research Center in Wyndmoor, PA., and at Weslaco, TX., with forage and crop residue research at WRRRC, RRRC, NRRC and Corvallis, OR.

Product quality and processing efficiency are the two researchable components, pertinent to this NRP, that impact on the spread between farm value and consumer cost. Quality, a major determinant of market demand and value, is composed of several factors--sensory (aroma, color, flavor and texture), nutritional and safety. Research on quality is concerned with a) identification of the compositional determinants of quality, b) the impact of production (cultural practices, variety, environment), harvesting, handling, storage and processing on these determinants, c) the mechanisms controlling variation (physical, chemical, biochemical, biological), and d) the analytical methodology required by researchers and regulatory agencies to measure and characterize quality and changes therein.

Processing efficiency research is concerned with a) conservation of energy and water, b) reduction in losses, c) utilization, control and/or elimination of environmental pollutants, and d) improved yield of acceptable products. In addition, much of the information developed on product quality has direct bearing on processing efficiency research.



Research under this NRP, therefore, ranges from basic to applied. The specific nature of current investigations varies with the commodity and provides not only guidance for the plant breeder and farmer but also information essential to the identification and development of new products and new systems to increase utilization, improve processing efficiency, and decrease consumer cost.

#### NRP 20530 Technologies for Food and Feed Uses - Animal Products

Effort under this NRP has been devoted to the study of meat, poultry, eggs and milk at six research locations. Significant accomplishments achieved toward the NRP's technological objectives summarized below resulted in 50 publications.

Meat: Protein nutritional quality of cattle organs and blood have been provided for use in dietary science and should aid in the more efficient use of animal carcass and upgrading for quality protein food. Biochemical studies showed that postmortem calcium release was an important factor affecting meat tenderness as is storage temperature and freeze-thaw cycling. New and improved methodologies were developed for meat process control, phosphoglyceride analyses and protein-lipid interactions.

Poultry: Cooperative studies with Natick established the beneficial effects of polyphosphate in correcting sensory defects in freeze-dried chicken. Cost saving achievements were attained with a fully automated hatchery waste handling system and energy value of poultry chiller water could be preserved through a cleanup process. Activated sludge waste treatments and sand filters offer promise in reducing pollution levels of poultry waste waters.

Milk: Utilization of whey in animal feeds was advanced by demonstration that whey lick-blocks and alfalfa hay doubled calves weight gain compared to alfalfa alone and that whey protein milk replacer was as effective as commercial casein based formulas. High quality food grade sirups for use in baked goods and confections were produced from hydrolyzed whey lactose. An immunoassay was developed for quantitation of whey protein in sausages for use by regulatory agencies and a protocol and specifications were developed for the manufacture of Mozzarella from CCC stocks of NDM. Thermally regenerable resins were demonstrated to be effective in whey demineralization. Biochemical studies established mechanisms of casein phosphorylation by the mammary gland and that it was unlikely that xanthine oxidase was a causative factor of atherogenesis in humans.

#### NRP 20540 Technologies for Industrial Uses - Plant and Animal Products

The program deals with basic and applied research related to four major commodities; cereal grain products, oilseed crops, animal fats, and hides. Current use: 3 billion pounds of starch, 2 billion pounds of oils, 2 billion

pounds of inedible tallow, and 3 billion pounds of hides. Potentially 150 billion pounds of starch are available. About one-half of inedible tallow and one-half of hides are exported as raw materials of lowest value each year. A principle research focus is to provide new technologies for converting these materials into products of high value contributing to national and farm income. Basic research is about 56 percent of the total program in industrial use of agricultural materials with most of this basic research being devoted to complex but useful chemical reactions for modifying starch and fatty acids. More applied work is devoted to processes and products leading to the Tannery of the 80's in which efficient use of energy, chemical processes, and labor are essential to a viable industry. A wide variety of products particularly useful to agriculture have resulted from this work as exemplified by starch-encapsulated slow-release pesticides.

#### NRP 20550 Technologies for Fiber Uses

This National Research Program deals with the entire spectrum of technologies involved with transforming natural fibers into consumer products. Cotton accounted for 84 percent of the \$10.5 million FY 1977 budget, with about 14 percent related to wool/mohair and 2 percent for kenaf. Seventy-eight percent of the program was distributed among three regional research centers, with much of the cotton work conducted by the Southern Regional Research Center in New Orleans, Louisiana. Wool/mohair research was concentrated at the Western Regional Research Center, Albany California, and kenaf at the Northern Regional Research Center, Peoria, Illinois. Ginning research was conducted by the three USDA ginning laboratories at Stoneville, Mississippi; Lubbock, Texas; and Mesilla Park, New Mexico; while measurement and maintenance of cotton quality was conducted by the Cotton Quality Research Station, Clemson, S.C.

More than 26 percent of the total program in FY 1977 fell within the category of basic research, dealing with basic fiber structure and the chemistry, physics and mechanics of processing and property development. An increasing emphasis, compared to previous years, was aimed at concerns of consumers and environmentalists. Nearly 8 percent of the 1977 budget was directed to improving flammability of apparel to meet safety standards established by the Consumer Product Safety Commission. Ten percent of the work was concerned with reducing health hazards related to cotton dust in response to proposed standards from the Occupational Safety and Health Administration. A significant effort went into maintaining environmental quality of air and water in response to Environmental Protection Agency requirements; and increasing attention was directed to reducing energy requirements in ginning and fiber manufacturing processes. Increases in these areas of broad public concern necessitated some de-emphasis of research related to improved efficiency and product performance which traditionally occupied much of the attention of scientists in this program. This trend is likely to continue.



NRP 20580 Technologies for Marketing - Fruits, Vegetables, Seeds, Nursery and Floral Products

Successful marketing of horticultural products requires an efficient system capable of providing high quality, nutritious and safe products to the consumer with adequate shelf life. Research under this program is conducted to increase the efficiency of marketing, and at the same time to reduce losses in harvesting, handling, storing and distribution. Several recent national study groups have stressed that more attention should be directed at the causes of food waste and on developing new technology for reducing losses. Present methods of handling fresh horticultural products from the farm through retail stores still are conducive to many losses.

The attached listing of current progress is divided into three sections representing the research objectives: a) develop new technologies for maintaining product quality and reducing losses, b) develop and evaluate techniques of quality measurement, and c) reduce costs in distribution and marketing systems by increasing physical efficiency and improving work methods. Both basic and applied research findings are presented. Of special interest may be new biochemical technology that offers many possibilities for regulating ripening and senescence of a wide range of horticultural products. Plant Physiologists, Plant Pathologists and Horticulturists have worked together to develop beneficial atmospheres to extend storage and retard physiological and pathological deterioration.

The information developed will aid in extending the season during which fresh commodities are available to consumers. More acceptable product quality at the consumer level will result in increased consumption of fruits and vegetables and increased demand for floral and nursery crops. Reduced wastage of products at all marketing levels should increase returns to producer and distributor and reduce cost to the consumer.

NRP 20590 Technologies for Marketing Field Crops

Grains and oilseeds pass through many hands, a number of handling firms, and various treatments and processes on their way from the farm to the table, feedlot or industrial firms where they are used. Food grains generally require more care in marketing and more processing than the feed grains. Principal concerns during the movement of field crops through the market channels are losses due to deterioration of quality, nutritional changes, mechanical injury and pathological and entomological infestations. Hence, basic research is conducted to (a) improve understanding of physiological processes occurring after harvest and their relation to maintaining product quality during storage, transportation and marketing, (b) improve standardization and efficiency of quality evaluation programs, (c) increase efficiency and conserve energy and materials during conditioning, handling, transportation and distribution, (d) improve understanding of host-parasitic relationships that provides a scientific basis for reduction of losses from invasion of micro-organisms, and (e) reduce losses of field crops in the marketing channels resulting in greater returns to producer and reduced costs to consumers.

NRP 20600 Technologies for Facilities for Marketing Livestock and Animal Products

The objectives of this research are to increase efficiency; reduce marketing costs; reduce losses; and evaluate, maintain, or improve quality of livestock and poultry and animal, poultry, and dairy products.

Progress was made on methods and materials for washing and sanitizing meat and poultry carcasses to reduce bacterial load and to assure the sanitizing agents have no detrimental effects on health of consumers or on the quality or flavor of the product. Improvements were made in identifying animal species used in meat products and in quality measurements of beef. A system of electrical shock to prevent "cold shortening" and toughening of beef muscle was tested. Electrically shocked hot carcasses were slightly more tender than those traditionally chilled. Two paired shipments of feeder calves, (373 head in 4 livestock trailers) were test shipped to determine causes of bruising, crippling, death and condemnation due to transportation. Proper designed and well lighted ramps and loading facilities resulted in reduced losses. Acceleration instruments have been obtained for future tests, but adequate instrumentation for measures of gasses and toxic fumes has not been located.

Improved facilities were developed for on-the-farm milk processing, dairy processing plants, farmer-operated beef processing, shell egg plants, and a dairy plant to convert cheese whey into food products. Preliminary research indicates microwave treatment of slaughtered poultry is an effective method to release feathers without damage to tissue. Technical assistance was provided the Foreign Agricultural Service and Food Safety and Quality Service on dairy, poultry, and meat processing and distribution.

NRP 20610 Technologies and Facilities for Marketing across Commodities

Improved procedures to clean and sanitize transportation equipment used for food were developed and a program established to encourage adoption of procedures and equipment to insure future improvements in food protection in transit.

Additional uses of near-infrared light reflectance as a measure of food quality were developed. This technique has now been adopted by FGIS for grading wheat and FGIS plans to adopt the technique for oil and protein measurement of soybeans. Karl Norris, Chief of the Instrumentation Research Laboratory, was recently awarded the Alexander von Humboldt award for the outstanding achievement in agricultural research. The award includes a \$10,000 prize for the scientist.

Cost reduction in food distribution was achieved through successful tests of the hopper-bottom boxcars which can haul both bulk and packaged goods, the development of procedures to save energy used to maintain cold storage of food, and development of a manual to assist direct marketing through improved farmers markets.



Studies of total marketing systems are nearly complete for potatoes, citrus and tomatoes and work is underway on onions, frozen food, dry groceries, beef and cherries.

Urban wholesale market plans were completed for northern New Jersey and Memphis and a report published on Ashville, N.C.

Improved small retail food store operations in low-income areas were developed and are being tested in several inner-city Washington, D.C. stores. Two hospital food program improvement projects have been undertaken with Department of Defense assistance.

#### NRP 20620 Insect Control in Marketing (Postharvest Insect Control)

A major philosophy within this NRP is that an important means of countering any threat of a world food shortage is to prevent destruction by insects of food that has already been produced. Increased production is not the only or even the best way to provide more food. If we could prevent the loss of food that is destroyed or ruined after harvest, there would be enough to feed 400 million people.

The objective of this research is to develop new or improved ways to prevent the postharvest loss, damage, destruction, or contamination by insects of food, feed, seed, and fiber. There are five primary lines of research directed to achieving this objective: (1) Basic biological research to learn more about the insects and to open the way to new physiological, biorational, or genetic control measures, (2) Biological control agents, (3) Physical control measures, (4) Conventional chemical control measures, and (5) Developing integrated pest management systems by scientifically combining components from all the preceding. There must be many such integrated systems to prevent insect attack on all the different kinds of harvested, raw commodities and on the many kinds of processed or manufactured products derived from agricultural commodities, as well as to control insects in the diversity of structures or facilities in which products are stored, processed, manufactured, shipped, sold, or used. The results of this research are needed by farmers, the food and feed industries, other agribusiness industries, consumers, and governmental regulatory or action agencies.

#### NRP 20650 Technologies and Products to Increase Exports of Agricultural Products

Meeting the needs of foreign markets for processed agricultural products that meet consumer acceptability and foreign governmental import restrictions is the challenge for this NRP. Assistance is also provided to give technical support to other governmental agencies charged with the responsibility for the distribution of food overseas. The development of new food and industrial products and processes that result in foods with improved qualities such as

nutritional, functional, stable, economical, safe and palatable, is the primary concern. New and improved processes that utilize rice and rice flour have been developed such as a new process for quick-cooking rice, a process for improving protein and mineral retention in brown rice, and the identification of properties needed to obtain moist, soft, smooth textured rice breads. Other examples include the development of a whole rice extruded soy mix product similar to corn-soy milk, and storage tests to improve storability of rice bread mix and flour. Information has been developed to select solvent composition and extraction temperatures that result in good soy flavor stability.

Other research looks at methods for preserving desirable color in fruit and fruit products to gain acceptance in foreign markets. For example, a process was developed to preserve the desirable light color in sun-dried peaches. Other work has developed an organic solvent to produce good color in oranges, and the use and application of bioregulators to control regreening and fungal resistance in citrus suggests some promising avenues for additional research.

#### NRP 20660 Systems for Overseas Marketing

This NRP is directed at research to help expand foreign markets for agricultural products and thus contributes directly to improving our balance of payments. It focuses primarily on quality maintenance and handling methods for agricultural products including horticultural crops, field crops, and livestock and animal products. It represents a relatively small research effort with good potential because the export market is substantial for the right products with the right quality and the right price. With other countries entering the export market with competing agricultural products, it becomes increasingly important to focus on conducting research to overcome existing quality and cost problems and to be able to meet revised import regulations of receiving countries.

Research is conducted to develop procedures to ensure good arrival condition of products that may not presently be exported due to excessive product losses, or to reduce losses and damage on current exports. For example, modified atmospheres and improved refrigeration practices have expanded export markets for fresh strawberries and research has played an important role in opening Far Eastern markets for cherries. Research has demonstrated that modified dry freight van containers can be used for grapefruit, onions, garlic and has backhaul potential for flower bulbs, thus reducing shipping costs over the conventional practice of utilizing refrigerated containers. Other research indicates potential with new loading patterns for fruits and vegetables, the feasibility of bulk bins, and procedures for reducing decay. Procedures have also been developed for better monitoring of air shipment of livestock and for better handling methods for livestock on ships.



## NRP 20820 Chemical Residues and Additives in Food and Feed

This National Research Program has provided qualitative and quantitative information on the occurrence of environmental contaminants in food and feed such as heavy metals. Methods were developed to measure the uptake of cadmium, zinc, copper, lead and mercury and their availability in the human diet. New technologies were developed to determine the presence and amount of nitrosamines found in cured meat as a result of the interaction of nitrites with certain amines. Methods were developed to inhibit this reaction by the addition of certain chemicals, such as sorbate and  $\alpha$ -tocopherol.

## NRP 20830 - Safe Products and Processes

Research has been aimed at developing new and improved methods for isolating, identifying and/or reducing toxic substances in cotton dust and tobacco that produce irreversible pulmonary disease in humans.

## NRP 20840 Natural Toxicants and Microbial Toxins

This National Research Program has produced valuable information on levels of toxicants occurring naturally in a wide variety of foods; provided new technologies for preventing, controlling and eliminating mycotoxins in certain agricultural commodities susceptible to fungal invasion; and developed new procedures for identifying and controlling certain food poisoning bacteria on poultry and red meat.

## NRP 20860 Family Use of Resources

Research information on the economic situation of families was developed and disseminated to the news media, State Extension agents, high school and college teachers, and other professional workers. New methodology was developed and used to compute service-life estimates for appliances according to household characteristics. An experimental test method was developed to predict the effects of laundering on blankets.

## NRP 20900 Food Composition and Improvement

Human nutrient requirements for optimal health, the subject of NRP 20910, are of little use to the public unless they can be expressed in terms of foods that furnish the required nutrients. This is the purpose of NRP 20900. Nutrient composition research and data dissemination traditionally have been the responsibility of the USDA.

The current effort to revise the basic reference, Agricultural Handbook No. 8, "Composition of Foods--Raw, Processed, Prepared," has revealed important knowledge gaps--foods and nutrients for which little or no reliable data presently exist. There are numerous reasons for these gaps, but primarily these gaps reflect, (a) new trends in the foods available to

the public, (b) nutrients whose importance has only recently come to light, and (c) the lack of adequate analytical methodology. It is difficult to assess priorities, but in general the needs for data are greatest for processed foods and commercially cooked foods. The nutrients related to public health problems in the U.S. for which we have the least data are trace minerals, some vitamins, and substances of recent interest, such as sodium, individual sugars, fiber components, and the fats and lipids. This NRP effort is directed toward dissemination of timely, accurate nutrient composition data to the scientific community, to the consuming public and to the other groups where these data are used. The program is broad in scope ranging from basic research on analytical methodology, to inhouse and contracted routine analyses, to nutrient data publication (printed and/or on computer readable media).

Of great importance was the finding that the daily intake of three essential trace elements from either self-selected diets or from diets designed to meet the RDA's, was clearly suboptimal. Progress has been made in the understanding of the action of dietary fiber and in the changes of amino acids during the processing of proteins yielding potentially toxic substance.

The importance of this NRP was emphasized in two Congressional Hearings: one in 1977 in the Senate Select Committee on Nutrition and Human Needs, the other in 1978 in the House Committee on Science and Technology.

#### NRP 20910 Human Requirements for Nutrients

The requirements for individual nutrients are poorly defined, must be estimated by extrapolation for certain age groups, and are estimated entirely from animal experiments for certain of the newer trace elements. As the public demands valid dietary recommendations conducive to good health, the human requirements for nutrients and certain non-nutrient components of the diet must be exactly quantified. The research efforts in this NRP are directed to some of the most pressing problems in human nutrition, such as excessive fat intake, uncertainty of human trace element requirements and possible marginal deficiencies, suspected suboptimal protein nutrition in high risk groups, protein overconsumption in the majority of the population, overconsumption of simple and possible underconsumption of complex carbohydrates. The research efforts were divided between basic approaches, such as the study of molecular mechanisms involved in intestinal absorption, and human studies immediately relevant to existing problems. The results of this research made very important contributions to our knowledge of human copper, zinc, and chromium requirement; it also established desirable levels of fat, sugar, and fiber intake. Basic research established methodologies of great potential importance in the future; it also suggested the existence of a hitherto unrecognized, essential trace element, arsenic.



NRP 20920 Food Consumption and Use

The year-long 1977-78 Nationwide Food Consumption Survey (NFCS) began on April 1, 1977. Information to be obtained from 15,000 sample households and over 30,000 household members will provide up-to-date measures of the food and nutritional content of the U.S. diet and shifts occurring since 1965-66, when the latest study was conducted. During the year, supplemental surveys were initiated among elderly and low-income households in the U.S. and in Puerto Rico. Plans were completed for additional surveys in Alaska and Hawaii to begin in January 1978. Data collection was being carried out under contract by the National Analysts Division of Booz, Allen and Hamilton, Inc. Technical food information support was provided by SEA. In July 1977, work was also initiated to develop a plan for further validation of results from the surveys in response to a GAO recommendation. Also, measures of the average per capita nutritional value of the U.S. food supply were updated and an analysis of trends in consumption of iron and magnesium was published.

Changes in food consumption patterns of men, women, and children that would bring them in line with the Dietary Goals for the United States (Senate Select Committee on Nutrition and Human Needs) were explored. An instruction book, A Guide for Precosting Food for School Food Service, was developed at the request of the Food and Nutrition Service (FNS) for use by food service managers in the National School Lunch Program (NSLP). Numerous recipes were developed, standardized, or both for use in child-care centers and NSLP; school children judged the acceptability of 16 of the recipes. Yield and use information were developed for FNS for commodities distributed by USDA to schools and other institutions. Assistance given on nutrition and nutrition education program and policy problems included developing background papers on policy issues, developing nutrition education policy recommendations, specifying changes needed in providing dietary guidance to the public, and providing basic information to support policy decisions. Practices used and spoilage experienced in home canning fruits and vegetables were identified in a nationwide study; both new and experienced home canners need to use safe, reliable home-canning instructions.



ANNUAL REPORT  
FY 1977

National Research Program 20510

TECHNOLOGIES FOR FOOD AND FEED USES - FRUITS AND VEGETABLES

This is one of the National Research Programs that contribute to the Department's mission on agricultural marketing and distribution. This contribution is made through the intergration of studies on the quality and composition of fruits and vegetables, the nature and degree of change during production, harvesting, storage and processing, and the quality and yield of the processed product. Such studies provide the information necessary to devise new products and changes in processing technologies necessary to meet a) energy and water shortages, b) stringent effluent guidelines, c) variations in the labor supply and cost, d) consumer needs for improved nutrition, quality, safety, convenient new food forms, and lower cost, and e) regulatory and action agency needs for research support.

NPS Contact: R. L. Handwerk

PACS Contact: C. Golumbic

Technological Objective 1:

Relate composition and properties of harvested fruits and vegetables as influenced by genetics, cultural practices, harvest practices and postharvest handling to cost, processing efficiency, usable yield and quality of processed products.

Research Locations:

Albany, California  
Pasadena, California  
Winter Haven, Florida  
Athens, Georgia  
East Grand Forks, Minnesota  
Raleigh, North Carolina  
Wyndmoor, Pennsylvania  
Weslaco, Texas  
Prosser, Washington

Selected Examples of Recent Progress:

Long-term studies on blackspot in potatoes - Albany, CA. Incidence of blackspot, and the enzymes associated with susceptibility to blackspot, increased when plants were grown in dry soil heavily fertilized with nitrogen.

Effects of flavor compounds on food product acceptability - Albany, CA. A possible off-flavor of beans, a compound produced by Streptomyces bacteria and possessing a urine-like odor, was indicated by mass, infrared, and NMR

spectra to be probably the compound cadin-1(10)-en-11-ol. A synthesis of the compound was carried out but the synthetic compound was structurally different from that produced by the bacteria even though it had a similar urine-like odor.

Taste tests show that as little as 6-12 PPM of the low-calorie sweetener neohesperidin dihydrochalcone (derived from grapefruit peel) significantly improved grapefruit juice acceptability by reducing naringen bitterness.

Thermal resistance of *Brassochlamys fulva* - Albany, CA. Death rate curves were determined for additional strains of *B. fulva* and a method devised to make these curves linear for use in processing calculations.

Methyl bromide as a microbicide - Albany, CA. Methyl bromide was shown to be effective in destroying *E. coli* and *S. typhimurium* inoculated on almond kernels, however, dosages or exposure times in excess of those used for fumigation of nuts for insects were necessary.

Laboratory distillation - extraction device was shown 80-95% efficient in recovery of typical food flavor volatiles - Albany, CA. This improved device, now produced commercially, is used in Europe, Japan and Australia. Current research results guide use of the apparatus and method.

Reduction of limonin content of juice from navel oranges may be possible by use of microbial enzymes - Pasadena, CA. Six organisms with abilities to metabolize limonoids were found in soil samples and bacterial cells immobilized in gel effectively converted limonate to the tasteless form.

Compositional changes in oils, juice and peel of oranges treated with abscission chemicals - Winter Haven, FL. Orange oil from Hamlin, Pineapple and Valencia oranges treated with Release or cyclohex contained several new compounds not previously reported as oil components. These compounds were methyl derivatives of eugenol (reportedly found in other fruits). Ethepon (ethylene-generating) did not cause creation of these new components. Taste panels detected differences between these oils and controls and generally preferred the controls.

Variety and maturity relationships with composition - Winter Haven, FL. TLC patterns of flavenoids and GLC profiles of lipids established relationships between several lipid and flavenoid classes and maturity, flavor characteristics and growth characteristics. Flavenoid studies indicated differences between nucellar and zygotic genetic material could be determined and predicted thus helping to avoid unnecessary transplanting and propagations of nucellar materials.

State quality standards established for naringen and limonin - Winter Haven, FL. Simple, reliable TLC methods and techniques for analyzing naringen and limonin were developed. Based on data gathered over two seasons, the State established standards of quality and the methods are now being utilized commercially to monitor these components in juices. Another class of compounds,

the coumarins, were found responsible for tartness and astringency imparting a "greenish" or "immature" flavor quality. Data gathering on these compounds has begun.

Explanation for the textural differences between Freestone and Clingstone peaches may result from the study of enzyme systems - Athens, GA. Freestone peaches contain two poly-galacturonases, one exo and one endo while Clingstone peaches contain only the exo form and no, or very little of the endo form. The existence of these differences suggests an approach for controlling oversoftening of Freestone peaches.

Rapid, accurate sucrose-rating (SR) test method developed - East Grand Forks, MN. The method is based upon color development when alkali treated tuber juice is reacted with anthrone solution at 40°C. Standard color tubes or color charts are compared for direct reading of SR.

Screening of breeding selections - East Grand Forks, MN. Evaluations by SR and potato chip color of advanced processing selections indicates several University of Minnesota and University of North Dakota selections have superior storage and processability characteristics to the well known Kennebec, Norchip and Russet Burbank varieties. Screening breeding stocks has increased the low-sucrose potential of Minnesota and North Dakota breeding stock from 46% to 79% in 1977.

Characterization and changes in phenolics in sweet potato basic to the discoloration problem - Raleigh, NC. Three chlorogenic glycerides, chlorogenic acid, isochlorogenic acid-1 and isochlorogenic acid-2 were found in all sweet potato cultivars analyzed. Some cultivars also contain traces of 4-O caffeoyl quinic acid. The concentration of phenols present ranged from 14.30 mg per 100 g in Centennial to 51.23 mg per 100 g in Australian canner.

After four weeks storage (of the jewel variety) at 61°F, neochlorogenic acid was found and its concentration increased with time. At 21 weeks neochlorogenic acid was the major phenolic present. The overall total phenolic content also increased with time.

Correlation of objective measurement of apple flavor quality with other physical and chemical measurements - Wyndmoor, PA. GLC data and other objective measurements of quality and ripeness, obtained for four apple cultivars subjected to different storage and ripening regimes were analyzed statistically. Significant and potentially useful relationships were found between data derived from nondestructive spectrophotometric or sonic resonance frequency measurements and volatile composition, soluble solids content and firmness with York Imperial, Rome Beauty, and Golden Delicious apples.



Jalapeno pepper strains evaluated - Weslaco, TX. As part of the service provided to Texas A&M University Experiment Station in selecting strains for a breeding program, nine strains were evaluated and two strains were judged superior in flavor, texture and color.

Growth regulators influence the quality of fresh and processed "Bing" cherries - Prosser, WA. The growth regulator, gibberellic acid, applied to "Ranier" sweet cherry trees at 20 PPM increased the vitamin C content of fresh and processed cherries by over 20% and Alar increased maturation rate and red color and decreased processed drained weight.

Controlled atmosphere storage of apples reduces applesauce yield and quality - Prosser, WA. Compared with ordinary (3°C) cold storage, controlled atmosphere (high CO<sub>2</sub>) storage reduces applesauce yield and quality.

Drained weight of canned pears decreased by use of insecticide - Prosser, WA. BAMM an insecticide used on pear trees decreased drained weight in canned pears.

New breeding lines and cultivars evaluated for processing characteristics - Prosser, WA. The new apricot cultivar "Rival" had clearer syrup, firmer texture and corroded can linings less than the Tilton variety when canned.

A new cultivar of dry pea, Garfield, was too soft when processed under normal procedures, however, addition of calcium salt made the product equivalent to the common Alaska variety. Calcium salt increased color in all eleven cultivars tested.

#### Technological Objective 2:

Reduce processing costs and improve markets for fruit and vegetables through innovative and improved processing technologies which increase efficiency and pollution control, reduce energy requirements, optimize nutrient retention, and provide safe new food forms with desired consumer product qualities.

#### Research Locations:

Albany, California  
Pasadena, California  
Winter Haven, Florida  
Athens, Georgia  
Honolulu, Hawaii  
Raleigh, North Carolina  
Wyndmoor, Pennsylvania  
Weslaco, Texas  
Prosser, Washington

Selected Examples of Recent Progress:

Processing technique changes effect changes in processing properties of potato cultivars - Albany, CA. Initial results show that selection of the proper cooking temperature and use of specific sequential applications of steam, water or hot air may effect improvements in processability of potato cultivars not now useful for processing.

Quick method for proximate analysis of oil in potato products - Albany, CA. A method was developed for analysis of oil, solids and water. The method requiring 2-3 hours correlated closely with the Soxhlet method (which requires 16-18 hours and gives only oil content).

Refried beans prepared from quick-cooking beans - Albany, CA. Taste panels demonstrated that refried beans made from quick cooking beans looked and tasted equal to or better than the best commercial brands and were superior to the lesser brands.

Peeling tomatoes using cyclical heating and cooling techniques - Albany, CA. Best peeling results were obtained with a three cycle heating/cooling method, however, green and yellow shouldered tomatoes required a light caustic pre-treatment. Experimental varieties with uniform-ripening and easy-peel-genes peel more readily by this method than other varieties.

Control of double dip lye peeling systems for potato peeling - Albany, CA. Potatoes of widely varying size and skin condition can be peeled satisfactorily by adjusting the residence time in the second lye applicator. Reduction in lye usage by 50-80% and peel losses by 25% over the single dip system are indicated.

Individual quick blancher commercially available - Albany, CA. The low effluent, low energy Vibratory Blancher Cooler having met objectives of 80% reduction in effluent volume and BOD and 80% of theoretical energy use is now commercialized with a firm offering units for sale.

Unit kernel sweet corn - Albany, CA. A second season of testing confirmed that unit (intact) kernel sweet corn is consistently preferred by taste panels over conventionally-cut products. A 15% increase in yield is realized for all varieties tested. Two equipment manufacturers have undertaken development of equipment for kernel removal.

Reduced harvest damage to tomatoes - Albany, CA. Foam and mechanical cushioning systems reduced fruit damage by 20-60% when incorporated into existing bulk handling equipment. Commercial application appears feasible.

Enzymes used to bring about beneficial changes in food composition and properties - Albany, CA. Invertase and  $\alpha$ -galactosidase physically entrained within the porous sponge region of some anisotropic hollow fibers were able



to essentially completely hydrolyze their respective substrates, sucrose and raffinose, with no detectable enzyme leakage. The immobilized invertase could be used to hydrolyze sucrose as the first step in production of fructose, a sweeter sugar. The immobilized  $\alpha$ -galactosidase could be used to hydrolyze the  $\alpha$ -galactosides in dry bean products to reduce flatulence and the raffinose that interferes with sucrose recovery from sugar beets. Glucoamylase immobilized on chitan with glutaraldehyde was evaluated with respect to its efficiency for hydrolysis of starch to glucose. The pH optimum in static tests was 4.1 compared to an optimum of 4.3 obtained with columns. The pH activity curve for columns was broad, exhibiting little change between pH 3.5 and 5.0. Columns were operated continuously with partially hydrolyzed starch solutions as feed mixtures without any apparent increase in back pressure for as long as 17 days. The column operated for 17 days had an estimated half-life of about 240 days. With a feed containing 30%  $\alpha$ -amylase hydrolyzed starch the concentration of glucose in the product solids was over 95%. Previous work indicates debittering of grapefruit juice with naringinase will be possible.

Snack products from beans with significantly increased protein content - Albany, CA. Highly acceptable snack products were prepared from blackeye, garbanzo and small white bean flours in combination with cereal grains. The blackeye bean combination exhibited a PER of 2.2 compared with 2.5 for casein.

Dehydration of cooked beans - Albany, CA. An optimum process for production of dehydrated flakes of cooked beans was developed using a single drum dryer.

Process for concurrent concentration of thin juice (Steffen filtrate) and dilution of beet molasses for sugar recovery - Albany, CA. Pilot trials indicate large energy savings are possible in beet sugar refining.

Infield fermentation of sugar containing wastes for alcohol production - Albany, CA. Rapid fermentation rates were achieved (96% in 8 hours) and projected rates are 96% in 3 hours with a new design, self agitating fermentor.

Economical solar collector and dryer for fruit - Albany, CA. A solar drying trough which reflected 100% of the incident radiation demonstrated 40-50% increased drying rate and less loss of sulfur dioxide than conventional systems.

Flavor stability of raisins dried on the vine and in tunnel dehydrators are equal or superior to traditionally tray dried fruit - Albany, CA. Methyl oleate assisted vine drying will eliminate drying yard labor. No flavor impairment was found from the methyl oleate.

Artificial sweetener derived from citrus peel, neohesperidin dihydrochalcone (NEO-DHC) is still awaiting approval by FDA - Pasadena, CA. Industry testing of NEO-DHC indicates that the compound could be used successfully in various



kinds of beverages. Many new DHC analogs have been reported, but NEO-DHC remains the outstanding compound of the group.

Detection of adulteration of orange drinks and juices - Pasadena, CA.

Modifications in the microbiological assay method gave a 5-fold increase in sensitivity and made detection of adulteration more sensitive. Possible ways of circumventing detection of adulteration are under evaluation. A non-parametric statistical approach to detection of adulteration on orange juice yielded a better level of detection and/or lower error rates.

New product from flavedo shaved grapefruit and oranges - Winter Haven, FL.

Vacuum infusion of naringinase, nutrients and flavor substances into flavedo shaved grapefruit was demonstrated. The grapefruit albedo was less bitter and more tolerable.

Utilization of d-limonene - Winter Haven, FL. The citrus byproduct, d-limonene was converted to more valuable chemicals useful in the asymmetric reduction of ketones.

Water chestnut growing, harvesting peeling and processing methods under adoption by producers and processors - Athens, GA. Requests for assistance from growers and processors indicated high interest in this crop for fresh and processing use.

Improved papaya processing procedures adopted by industry - Honolulu, HI.

Processes designed to minimize deleterious enzymatic actions (which result in off flavor, gelling and formation of malodorous compounds) were adopted for local utilization of fruit unsuitable for fresh market use.

Development of a basis for controlled fermentation procedures for sliced large cucumbers - Raleigh, NC. Lowered levels of salt, heating of the slices and addition of calcium acetate buffer resulted in increased yields, firmer slices and less waste. Increased brine depth and CO<sub>2</sub> removal were found to reduce bloater damage, however, purging with air may stimulate growth of undesirable aerobic organisms.

Continuous explosion drying systems for fruits and vegetables - Wyndmoor, PA.

A continuous system for explosion puff drying was developed and demonstrated producing puffed, diced potatoes, apple wedges, and blueberries. Industry is following with interest the last stages of equipment refinement and process optimization.

Methods for recovery of starch and fructose from potato blanch water -

Wyndmoor, PA. All of the soluble starch and 65% of the sucrose present in simulated potato blanch water can be separated by means of calcium hydroxide treatment (reducing the COD of the effluent by 20-28%). Commercial application is possible, however, profitable end use must first be found for the soluble starch and large amounts of calcium hydroxide are required. This project is terminated.

Natural plant pigments as potential red food colorants - Wyndmoor, PA.

Pigment extracts from a number of cultivars of edible and nonedible plants were evaluated for stability in model systems simulating typical artificially colored food products. Red lettuce and red cabbage pigments show promise, however, flavor may be a problem with the latter. Large differences in betacyanin and betaxanthin contents, affecting color intensity and hue, were found between 48 beet cultivars tested. Research on enhancing betanin stability has yielded promising results.

Flavor of Star Ruby and Ruby grapefruit juice stored at ambient temperature - Weslaco, TX. Ruby grapefruit juice changes less on storage than Star Ruby, however, color contributed by Star Ruby is more desirable. A 30-40% Star Ruby juice is the best compromise.

Carrot pies found acceptable when compared with pumpkin pies - Weslaco, TX. Carrot pie mix, canned in the same manner as pumpkin pie mix has superior nutritive value and apparently equivalent acceptability when made into pies.

Seed index (weight X length) correlates well with fiber content of snap beans - Prosser, WA. An efficient measure of quality of snap beans that describes seed size correlates with the cumbersome fiber analysis method and was effective in varietal screening tests.



PUBLICATIONS

Albany, California

Binder, R. G., J. M. Klisiewicz, and A. C. Waiss, Jr. Stimulation of Puccinia carthami teliospores by polyacetylene from safflower. Phytopathology. 67:472-474. 1977.

Bomben, J. L. and J. S. Hudson. Cooked weight and solids loss of air cooled and water cooled frozen vegetables. J. Food Sci. 42(4):1128-1131. 1977.

Brown, M. S. Texture of frozen fruits and vegetables. J. Texture Studies. 7:391-404. 1977.

Buttery, R. G. and L. C. Ling. A three-step synthesis of cadin-1(10)-en-11-ol. J. Agric. Food Chem. 25:291. 1977.

Finley, J. W., W. L. Stanley, and G. G. Watters. Removal of chill haze from beer with papain immobilized on chitin. Biotechnol. Bioeng. 19:1895-1897. 1977.

Fuller, G., W. W. Spooncer, A. D. King, Jr., J. Schade, and B. Mackey. Survey of aflatoxin in California tree nuts. J. Amer. Oil Chemists' Soc. 54:231A-234A. 1977.

Gee, M., D. F. Farkas, and A. R. Rahman. Some concepts for the development of intermediate moisture foods. Food Tech. 31:58-64. 1977.

Guadagni, D. G., R. M. Horowitz, B. Gentili, and V. P. Maier. Method of reducing bitterness and off-aftertaste. U.S. Patent Serial #758,987. 1977.

Guadagni, D. G., R. M. Horowitz, B. Gentili, and V. P. Maier. Method of reducing bitterness in citrus juices. U.S. Patent Serial #4,031,265. 1977.

Hahn, D. M., F. T. Jones, I. Akhavan, and L. B. Rockland. Light and SEM studies on dry beans: Intracellular gelatinization of starch in cotyledons of large lima beans (Phaseolus luratus). J. Food Sci. 42:1208-1212. 1977.

King, A. D., Jr., H. G. Bayne, and G. Alderton. Nonlogarithmic heat and radiation resistance of bacterial and fungal spores and bacteria with calculation of lethalties. Abstracts of annual meeting, Amer. Soc. for Microbiology. p. 246. 1977.

Kon, S. and C. J. Dunlap. Ready to eat legume chips prepared from legume powder. U.S. Patent--allowed in December 1977.

Kon, S. and C. J. Dunlap. Snack foods from legumes. Food Prod. Dev. 11(September):77-78. 1977.

Kon, S., D. S. Sanshuck, R. Jackson, and C. C. Huxsoll. Air classification of bean flour. J. Food Processing and Preservation. 1:69-77. 1977.

Kon, S. and S. Schwimmer. Depolymerization of polysaccharides by active oxygen species derived from a xanthine oxidase system. J. Food Biochem. 1:141-152.

Kon, S. and J. R. Wagner. Partial separation and characterization of alpha-galactosidase from Phaseolus vulgaris. Food Sci. and Technol. 10:106-108. 1977.

Korus, R. A. and A. C. Olson. The use of alpha-galactosidase and invertase in hollow fiber reactors. Biotechnol. Bioeng. 19:1-8. 1977.

Nonaka, M., R. N. Sayre, and M. L. Weaver. Oil content of French fries as affected by blanching temperature, fry temperatures, and melting point of frying oils. Amer. Pot. J. 54:151-159. 1977.

Olson, A. C. and R. A. Korus. Immobilized enzymes in ACS Symposium Series No. 47, Enzymes in Food and Beverage Processing, R. L. Ory and A. J. St. Angelo, editors. pp. 100-131. 1977.

O'Meara, J. L., D. F. Farkas, and C. K. Wadsworth. Flexible pouch sterilization using a combined microwave heat-hot water hold simulator. Technical Report. U.S. Army Natick Development Center. 1977.

Randall, J. M., W. M. Camirand, and K. Popper. Application of product return osmosis to reduce energy in beet-sugar processing. Proc. of International Conference on Energy Use Management, Tucson, Arizona. 1:837-844. 1977.

Robertson, G. H., J. M. Krochta, M. L. Lazar, and D. F. Farkas. Unit operations for generation of intact or unit kernels of sweet corn. J. Food Sci. 42(5):1290-1293, 1303. 1977.

Robertson, G. L., M. E. Lazar, J. M. Krochta, and D. F. Farkas. Intact or unit-kernel sweet corn. Food Tech. 31(8):58-66. 1977.

Rockland, L. B. Retention of protein quality in quick-cooking beans prepared from dry beans. Proc. IV Int. Congress of Foods. Sci. & Technol. 1:611-612. 1977.

Rockland, L. B., D. M. Hahn, and E. M. Zaragosa. Quick-cooking frozen beans. Food Prod. Dev. 11(3):34. 1977.

Rockland, L. B., F. T. Jones, and D. M. Hahn. Light and scanning electron microscope studies on dry beans; extracellular gelatinization of lima bean starch in water and a mixed salt solution. J. Food Sci. 42:1204-1207, 1212. 1977.



Schade, J. E. and A. D. King, Jr. Methyl bromide as a microbicidal fumigant for tree nuts. Applied and Environmental Microbiology. 33:1184-1191. 1977.

Schultz, R. R., R. A. Flath, T. R. Mon, S. B. Eggling and R. Teranishi. Isolation of volatile components from a model system. J. Agric. Food Chem. 25(3):446. 1977.

Schultz, W. G., H. J. Neumann, J. E. Schade, J. P. Morgan, A. M. Katsuyama, and J. H. Maagdenberg. Commercial feasibility of recovering tomato peeling residuals. EPA-600/22-77-184. Proceedings of Eight National Symposium on Food Processing Wastes. 1977.

Stafford, A. E. and D. G. Guadagni. Storage stability of raisins dried by different methods. J. Food Sci. 42:547. 1977.

U.S. Patent application, Serial #803,193. Precooked baking potatoes. Filed June 23, 1977.

U.S. Patent application, Serial #809,355. Precooked fruits and vegetables. Filed June 23, 1977.

Wagner, J. R., J. F. Carson, R. Becker, M. R. Gumbmann, and I. E. Danhof. Comparative flatulence activity of beans and bean fractions for man and the rat. J. Nutr. 107(4):688-689. 1977.

Waiss, A. C., Jr., B. G. Chan, and C. A. Elliger. Host plant resistance to insects in host plant resistance to pest. Amer. Chem. Soc., Symposium. Ser. No. 62, P. A. Hedin, Ed. 1977.

Waiss, A. C., Jr., B. G. Chan, C. A. Elliger, V. H. Garrett, E. C. Carlson, and B. Beard. Larvicidal factors contributing to host plant resistance against sunflower moth. Naturwissenschaften. 64:341. 1977

Wick, E. and K. Popper. Continuous fermentation in slant tubes. Biotechnology and Bioeng. 19:235-246. 1977.

Zaragosa, E. M., L. B. Rockland, and D. G. Guadagni. Canned refried beans prepared from quick-cooking beans. J. Food Sci. 42:921-923. 1977.

#### Pasadena, California

Asen, S. and R. M. Horowitz. 2"-O-Acetylquercitrin from azalea flowers. Phytochemistry 16:147-148. 1977.

Guadagni, D. C., R. M. Horowitz, B. Gentili, and V. P. Maier. Method of reducing bitterness in citrus juices. U.S. Patent 4,031,265, June 21, 1977.

Hasegawa, S. and J. E. Hoagland. Biosynthesis of limonoids in citrus. *Phytochemistry* 16:469-471. 1977.

Hasegawa, S., H. Yokoyama, and J. E. Hoagland. Inhibition of limonoid biosynthesis in leaves of Citrus limon by triethylamine derivatives. *Phytochemistry* 16:1083-1085. 1977.

Maier, V. P., R. D. Bennett and S. Hasegawa. Limonin and other limonoids. Chapter 9 in *Citrus Science and Technology Volume I* (pp 355-396) edited by S. Nagy, P. E. Shaw and M. K. Veldhuis, Avi Publishing Company, Inc., Westport, Connecticut. 1977.

Horowitz, R. M. and B. Gentili. Flavonoid constituents of citrus. Chapter 10 in *Citrus Processing Science and Technology, Volume I* (pp 397-426) edited by S. Nagy, P. Shaw and M. K. Veldhuis, Avi Publishing Co., Westport, Connecticut. 1977.

Raymond, W. R. and V. P. Maier. Chalcone cyclase and flavonoid biosynthesis in grapefruit. *Phytochemistry* 16:1535-1539. 1977.

Vandercook, C. E. Detection of adulteration in citrus juice beverages. *Fd. Chem.* 2:219-233. 1977.

Vandercook, C. E. Organic acids, Chapter 5, pp. 208-228 and Nitrogenous compounds, Chapter 6, pp. 229-265, in *Citrus Science and Technology, Volume 1*, edited by S. Nagy, P. E. Shaw and M. Veldhuis, Avi Publishing Company, Inc., Westport, Connecticut. 1977.

#### Winter Haven, Florida

Berry, R. E., C. J. Wagner, Jr., and P. E. Shaw. Promising products from tropical fruits. *Food Prod. Dev.* pp. 109-112. May 1977.

Bruemmer, J. H., R. A. Baker, and B. Roe. Enzymes affecting flavor and appearance of citrus products. *ACS Symposium Series*, No. 47, *Enzymes in Food and Beverage Processing*, pp. 1-11, 1977.

Bryan, W. L., E. D. Lund, and C. J. Wagner, Jr. Adsorption of flavor components from aqueous orange peel aroma solutions. *Ind. Eng. Chem., Prod. Res. Dev.* 16(3):257-261. 1977.

Lund, E. D. and W. L. Bryan. Commercial orange essence: Comparison of composition and methods of analysis. *J. Food Sci.* 42(2):385-388. 1977.

Lund, E. D. and P. E. Shaw. Asymmetric reduction of acetophenone with lithium aluminum hydride complexes of terpenic glycols. *J. Organic Chem.* 42:2073-2076. 1977.



Lund, E. D. and R. L. Coleman. Concentrated orange flavoring powder based on methanol-treated starch. International Flavors and Food Additives, September/October, pp. 193-195. 1977.

Nagy, S. and J. M. Smoot. Temperature and storage effects on percent retention and percent U.S. Recommended Dietary Allowance of vitamin C in canned single strength orange juice. J. Agric. Food Chem. 25(1):135-138. 1977.

Nordby, H. E. and S. Nagy. Relationship of alkane and alkene long-chain hydrocarbon profiles to maturity of sweet oranges. J. Agric. Food Chem. 25(2):224-228. 1977.

Nordby, H. E. and S. Nagy. Hydrocarbons from epicuticular waxes of citrus peels. Phytochem. 16:1393-1397. 1977.

Moshonas, M. G. and P. E. Shaw. Effects of abscission agents on composition and flavor of cold-pressed orange peel oil. J. Agric. Food Chem. 25(5):1151-1153. 1977.

Moshonas, M. G. and P. E. Shaw. Evaluation of juice flavor and peel oil composition of ethylene-treated (degreened) Hamlin oranges. International flavors and food additives, July/August 1977.

Shaw, P. E. and R. E. Berry. Hexose-amino acid degradation studies involving formation of pyrroles, furans, and other low molecular weight products. J. Agric. Food Chem. 25(3):641-644. 1977.

Shaw, P. E., J. H. Tatum, and R. E. Berry. Nonenzymic browning in orange juice and in model systems. Developments in Food Carbohydrate - 1, G. G. Birch and R. S. Shallenberger, Eds., Applied Science Publishers, Ltd., London, Chapter 6, pgs. 91-111. 1977.

Tatum, J. H. and Berry, R. E. 6,7-Dimethoxycoumarin in the peels of citrus. Phytochem. 16, pp. 1091-1092. 1977.

Wilson, C. W. and P. E. Shaw. Separation of pigments, flavonoids, and flavor fractions from citrus oils by gel permeation chromatography. J. Agric. Food Chem. 25(2):221-224. 1977.

#### Athens, Georgia

Birth, Gerald S. Nondestructive quality evaluation of agricultural products: Introduction. J. of Food Protection, Jan. 1978.

Birth, Gerald S. Interaction between light and biological materials. Proceedings of the 13th Annual Meeting of the Southern Regional Avian Environmental Physiological and Bioengineering Study Group, Jan. 23, 1977, Atlanta, GA.

- Birth, G. S. Applications of radiometric measurements to nondestructive evaluation of food quality: Data interpretation. Proceedings of the First International Congress on Engineering and Food, Boston, Mass., August 9-12, 1976.
- Birth, G. S. Instructional material for teaching optical properties of foods. Proceedings of the First International Congress on Engineering and Food, Boston, Mass., August 9-13, 1976.
- Birth, Gerald S. Applications of electro optical techniques to nondestructive quality evaluation of foods. The Society of Photo-Optical Instrumentation Engineers Proceedings, Vol. 129.
- Birth, Gerald S., C. E. Davis, and W. E. Townsend. The scatter coefficient as a measure of port quality. J. An. Sci. 44. March 1978.
- Davis, C. E., G. S. Birth, and W. E. Townsend. Analysis of spectral reflectance for measuring port quality. J. An. Sci. 44, March 1978.
- Dull, Gerald G. Nondestructive quality evaluation of agricultural products: A definition and practical approach. J. of Food Protection. Vol. 41(1):50. 1978.
- Nelson, S. O. Use of electrical properties for grain-moisture measurement. J. Microwave Power. 12:67-72. 1977.
- Nelson, S. O. Electrical properties of grain and other food materials. Proceedings of the First International Congress on Engineering and Food, Boston, Mass., August 9-13, 1976.
- Nelson, S. O. Microwave dielectric properties of insects and grain kernels. J. Microwave Power. 11:299-303. 1976.
- Nelson, S. O., R. M. Heckert, L. E. Stetson, and W. W. Wolf. Radiofrequency electrical treatment effects on dormancy and longevity of seed. J. Seed Technol. 1:31-43. 1976.
- Nelson, S. O., W. R. Kehr, L. E. Stetson, and W. W. Wolf. Laboratory germination and sand emergence responses of alfalfa seed to radiofrequency electrical treatment. Crop Science 17:67-72. 1977.
- Pressey, R. Enzymes involved in fruit softening. ACS Symposium, Series 47:172-191. 1977.
- Pressey, R. and J. K. Avants. Occurrence and properties of polygalacturonase in avena and other plants. Plant Physiol. 60:548-553. 1977.



Rai, P. S., H. J. Ball, S. O. Nelson, and L. E. Stetson. Spermatozoan activity and insemination in Tenebrio molitor following radiofrequency electrical treatment (Coleoptera: Tenebrionidae). Ann. Entomol. Soc. Am. 70:282-284. 1977.

Williams, A. K. Hydrogen peroxide bleaching of caustic peeled Chinese waterchestnuts. Lebensmittel-Wissenschaft Technology.

#### Honolulu, Hawaii

Brekke, J. E., H. T. Chan, Jr., K. L. Hibbard, T. O. M. Nakayama, R. C. Someda, A. L. Myers, and C. G. Cavaletto. Operating manual for papaya puree processing. Departmental paper no. 47 - July 1977. Hawaii Agric. Exp. Sta., University of Hawaii.

Brekke, J. E., C. R. N. de Aquino, and A. L. Myers. Viscometric behavior of guava purees and concentrates. J. Food Sci. 43:272. 1978.

Chan, H. T., Jr., R. A. Heu, C. S. Tang, E. N. Okazaki, and S. M. Ishizaki. Composition of papaya seeds. J. Food Sci. 43:255. 1978.

Chan, H. T., Jr., T. H. C. Kao-Jao, and T. O. M. Nakayama. Anthocyanin composition of taro. J. Food Sci. 42:19-21.

#### Raleigh, North Carolina

Fleming, H. P., R. L. Thompson, T. A. Bell, and R. J. Monroe. Effect of brine depth on physical properties of brine-stock cucumbers. J. Food Sci. 42:1464-1470. 1977.

Pharr, D. N., H. N. Sox, E. L. Smart, R. L. Lower, and H. P. Fleming. Identification and distribution of soluble saccharides in pickling cucumber plants and their fate in fermentation. J. Amer. Soc. Hort. Sci. 102:406-409. 1977.

Purcell, A. E., D. T. Pope, and W. M. Walter, Jr. Effect of length of growing season on protein content of sweet potato cultivars. Hort. Sci. 11:31. 1976.

Purcell, A. E., W. M. Walter, Jr., and F. G. Giesbrecht. Distribution of protein within sweet potato roots. J. Ag. Food Chem. 24:64-66. 1976.

#### Philadelphia, Pennsylvania

Heiland, W. K., J. F. Sullivan, R. P. Konstance, J. C. Craig, Jr., J. Cording, Jr., and N. C. Aceto. A continuous explosion-puffing system. Food Tech. 31:32, 33, 36. 1977.

Sapers, G. M., J. Abbott, D. Massie, A. Watada, and E. E. Finney, Jr. Volatile composition of McIntosh apple juice as a function of maturity and ripeness indices. J. Food Sci. 42:44-47. 1977.

Sullivan, J. F., R. P. Konstance, N. C. Aceto, W. K. Heiland, and J. C. Craig, Jr. Continuous explosion-puffing of potatoes. J. Food Sci. 42:1462, 1463, 1470. 1977.

Sullivan, J. F., R. P. Konstance, and W. K. Heiland. Doctoring and drying method. U.S. Patent No. 4,031,252, Issued 6/21/77.

#### Weslaco, Texas

Cruse, R. R. and B. J. Lime. Content and seasonal variation of L-ascorbic acid in Texas ruby red grapefruit. J. Rio Grande Valley Hort. Soc. 31:53-58. 1977.

Cruse, R. R. and B. J. Lime. The content and seasonal variation of L-ascorbic acid in Texas oranges. J. Rio Grande Valley Hort. Soc. 31:59-63. 1977.

#### Prosser, Washington

Drake, S. R., R. A. Kluter, and L. C. Hinnergardt. Textured soy protein improves quality of freeze dried beef patties. Food Technol. 31(10):24-30, 1977.

Drake, S. R. and J. W. Nelson. Fruit and vegetable processing update. Proc. Wash. Hortic. Soc. pp. 155-158. 1977.

Drake, S. R., J. W. Nelson, and T. K. Toyama. The influence of cultivar on drained weight and can corrosion in processed apricots. J. Am. Soc. Hortic. Sci. 103(1):49-51. 1978.

Nelson, J. W., S. R. Drake, G. H. Carter, and R. E. Early. Fresh asparagus quality as affected by field cut and holding condition. Wash. State Agric. Exp. Sta. Bull. 846. 3p. 1977.



ANNUAL REPORT  
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National Research Program 20520

TECHNOLOGIES FOR FOOD AND FEED USES - FIELD CROPS

This is one of three National Research Programs concerned with processing technologies of raw agricultural products. Contributions in this area are made through the integration of studies on the quality and composition of field crops (oilseeds, grains, forages and cellulosic materials, sugar crops), on the nature and degree of change during production, harvesting, storage and processing, on the quality and yield of the processed product and the efficiency with which it is produced. Such studies will provide the information necessary to devise changes in processing technologies, new products and new systems needed to meet a) energy and water shortages, b) stringent environmental guidelines, c) variations in labor supply and cost, and d) consumer needs for improved nutrition, quality, safety, convenience, and lower cost.

NPS Contact: W. H. Martinez

C. Columbic

Technological Objective 1.

Relate composition and properties of raw materials as influenced by genetics, cultural practices, harvest practices and postharvest handling to cost, usable yield and quality of processed products.

Research Locations:

Albany, California  
Athens, Georgia  
Peoria, Illinois  
New Orleans, Louisiana  
Wyndmoor, Pennsylvania  
Weslaco, Texas

Selected Examples of Recent Progress:

TO 1

OILSEEDS

Variation in sunflower seed composition with maturation - Athens, GA.

Seed dry weight, oil and triglyceride contents were found to be maximum 35 days after the initiation of flowering (DAF) and when the seed moisture content was 36%. This point, defined as physiological maturity for sunflowers, is about 93 days after planting and at least four weeks before dehydration needed for mechanical harvesting. Beginning with 14 DAF, the

linoleic acid content increased to a maximum of 59.2% by 56 DAF; whereas, oleic acid content decreased to 31.4%. An analysis of variance of linoleic and oleic acid contents from 21 DAF to 70 DAF show a highly significant change in composition with maturation time. Increase in free fatty acids after physiological maturity indicated deterioration of seed oil. Results suggest that the use of chemical desiccants shortly after physiological maturity would minimize oil quality deterioration and reduce susceptibility to bird and insect damage.

Total oil content and fatty acid composition of sunflower seed from the 1976 National Sunflower Performance Trials determined - Athens, GA.

Analyses were conducted on 12 sunflower hybrid and open pollinated varieties grown at 24 locations in 21 states and one location each in Rio Bravo, Mexico and Morden, Manitoba, Canada. Total oil content ranged from 33.2-53.8% with an average of 46.9% for all locations. Linoleic acid content ranged from 31.8-74.0% with an average of 55.7% at all locations. Fatty acid composition data showed a significant temperature effect. Sunflower plantings in which the average daily temperature from the period of full bloom to harvesting was 70 F or lower, in general, had linoleic acid contents between 62-74%; whereas, plantings with mean temperature above 70 F had linoleic acid contents between 32-60%.

Effect of drying time and temperature on sunflower seed germination and oil quality - Athens, GA. Sunflowers were harvested at 101, 107, 111 and 124 days after planting at moisture levels of 43, 31, 22 and 15% respectively. The seed were dried at 35, 53, 72 and 88 C to a moisture level between 5-10%. Free fatty acids in the low moisture samples were higher than at the other moisture levels. Percent germination showed a marked decrease with increasing drying temperature and an increase with decreasing initial moisture levels. Differences in drying time for samples of similar moisture suggest other factors affecting moisture release.

Composition of breeders stocks and commercial production of soybeans - Peoria, IL. During the last quarter of the year over 6,000 soybean samples were received from southern and northern United States and Canada. These were examined for oil and protein, and the results reported. In addition, more than 1,500 samples from the 1977 harvest were analyzed for the Federal Grain Inspection Service. The analysis of the 1977 harvest was part of a six-agency cooperative project.

New methods for chemical analysis of soybeans - Peoria, IL. An automatic method for nitrogen determination of whole soybeans was developed. This procedure will analyze 30 or more samples per hour. Procedures for rapid determination of fatty acid composition of soybean oil are near completion. This gas chromatographic method should accurately analyze 4 to 5 samples per hour.



Impact of export system on soybean quality - Peoria, IL. Samples of soybeans obtained from a second, identity-preserved shipment (New Orleans to Tilbury, England) were fractionated into (1) composite, (2) whole, and (3) split bean fractions. Chemical analysis (iron, free fatty acids, peroxide values, and phosphorus) of extracted crude oils showed that split beans are the precursors of deleterious prooxidants, refining loss factors, and potential off flavor materials in crude oils. Degumming of the crude oils was accomplished in the laboratory and these studies indicated that nonhydratable phosphatides increase markedly during export shipment.

Distribution of cadmium in soybeans grown on soils treated with sewage sludge - Peoria, IL. At the request of the Food and Drug Administration, a study was conducted to determine the fate of cadmium during processing of soybeans. Cadmium remained mainly in the flakes when the oil was removed but tended to distribute evenly between protein and nonprotein fractions on subsequent fractionation of the defatted flakes into isolates and concentrates. Present processing techniques are, therefore, unsatisfactory for removal of high levels of cadmium from soybeans.

Evaluation of cottonseed quality - New Orleans, LA. One lot, representative of the 1976 crop year, was obtained from each of the seven major cottonbelt growing areas and analyzed for major quality factors. Samples from Southwest Texas had highest protein - lowest oil; those from Mississippi Valley were vice versa. Kernels from the Lower Rio Grande Valley had highest gossypol, while those from the Texas High Plains area were lowest. Gel electrophoretic patterns showed no qualitative variations in protein content.

Microscopic examination showed no differences in kernel morphology between seed lots. Relative density, seed coat damage, and seed maturity of acid delinted seed were determined. Significant differences existed between seed lots for each of the three factors.

Predictive measure of roasted peanut flavor - New Orleans, LA. Direct gas chromatography appears to be an effective means of predicting differences in potential flavor quality of raw peanuts cured under various conditions. The gas chromatographic data from a series of 80 samples gave significant correlations ( $p=.01$ ) with taste panel flavor scores of the roasted nuts.

Impact of temperature on volatiles in raw peanuts - New Orleans, LA. Exploratory studies indicate that total volatiles, particularly methanol, acetaldehyde, ethanol, dimethylsulfide crotonaldehyde, chloropentane, hexanal, and hexanol, were much higher in peanuts exposed to freezing temperatures after digging (100% freeze damaged) than in the same crop of peanuts dug and removed from the windrows before the freeze. Limited studies indicate a loss of volatiles in raw peanuts stored at room temperature, some buildup at 7° and a greater buildup of volatiles at - 22° C.

Direct Gas Chromatograph as a breeding tool - New Orleans, LA. Preliminary results from 105 breeding lines of peanuts (early and intermediate generation levels, advanced selections and cultivars) indicate that direct gas chromatographic analyses should expedite the elimination of breeding lines which would not produce acceptable roasted products.

Impact of blanching conditions on raw peanut surface and relationships to shelf life - New Orleans, LA. Examination of water-blanching, dry-blanching and spin-blanching peanuts with the scanning electron microscope showed distinct differences between the three treatments. Data indicate that glazed coating on the surface of water-blanching peanuts, absent from dry-blanching peanuts, contains oxidized lipids, and suggests that although water-blanching is faster, shelf-life may be reduced.

## GRAINS

Influence of environment on variability in protein complement of wheat - Albany, CA. The quantitative SDS electrophoretic method was used to compare variability of proteins in a single variety (Scout 66) with area or year of production. Only minor differences in pattern were found for growth in different locations and/or in different years. This provides evidence that the distribution of proteins among classes is a stable genetic trait that is little influenced by environment. Though overall protein content can be influenced by environment (weather, soil, fertilizer).

Genetic relationships among the storage proteins of wheat - Albany, CA. Purified omega-gliadin proteins were prepared and sequenced; one an omega-gliadin component, coded for by genes on chromosome 1D, the other an omega-gliadin coded for by genes on chromosome 1B, both from the same wheat variety, Justin (HRS). The two sequences differed substantially (although some homology was evident) and also differed from the sequences of alpha-, beta-, and gamma-gliadins. Homology between the 1D omega-gliadin from Justin and that from *Ae. squarrosa* tended to support this species as the donor of the D genome to bread wheats. The omega gliadin from T. monococcum showed more homology with the 1B omega-gliadin from Justin than with the 1D omega-gliadin from Justin. This is notable because the B genome is usually considered to have its ancestry in some species of Aegilops rather than in a species of Triticum.

Studies of protein synthesis in wheat lines with substituted (possibly translocated) or added Agropyron chromosomes, have shown that the addition line has increased protein levels for all classes of components, whereas the substitution line did not. This may be a dosage effect of a gene related to high-protein levels in wheat. Identification of that gene might provide a means to increase protein levels in wheat.

Increased understanding of wheat protein structure and genetic relationship - Albany, CA. The finding that bread wheat gliadins (prolamines) can be assigned to two major groups on the basis of N-terminal amino acid sequences is of major significance. This provides the first solid evidence that these proteins are analogous to proteins that are specified by multigene families of the type that code for immunoglobulins and histones. It is thought that the function of multigene families is to provide for rapid synthesis of a single product or a number of closely related products, as is the case with antibodies. This finding means that all the extensive information that has been gleaned for other multigene families may be applicable to wheat storage proteins; progress in understanding genetic control and manipulation of wheat storage proteins should be greatly enhanced.



Relationship between protein complement and baking characteristics of wheat - Albany, CA. Previous studies of molecular weight classes of Scout 66, Red River 68, and Bankuti 1508 were extended to Atlas 66 and Omar. All varieties show quantitative differences from one another. Some qualitative differences by class were evident, as well. The most notable difference found was the high level of components with molecular weight near 50,000 in Red River 68, a variety noted for strong dough-mixing characteristics.

Stored product insect resistance associated with albumin content of wheat - Albany, CA. In cooperation with the ARS Grain Marketing Research Center, two varieties of wheat grown in different locations in the midwest were studied. Assays showed a positive correlation between their resistance to postharvest attack by the rice weevil and their content of albumin protein which inhibits rice weevil larval  $\alpha$ -amylase.

Effect of genetic variation on the complement of corn and sorghum grain proteins - Peoria, IL. Electrophoretic comparisons were made between alcohol-soluble proteins from normal and high-lysine whole sorghum meals. Electrophoretic patterns for near isogenic normal and high-lysine genotypes were similar, but different between unrelated varieties. Normal and high-lysine sorghums must differ in quantities rather than in kind of protein.

Zeins were isolated from opaque-2 corn, its near-isogenic normal line, and from another normal hybrid, and were subjected to amino-terminal amino acid sequence analysis. In all cases, primarily a single sequence was found, demonstrating significant homology or relatedness among zein polypeptides, and suggesting that they have arisen from a common ancestral gene. Very few sequence differences were noted between o-2 and near-isogenic normal zein, suggesting that the 0-2 gene suppresses primarily the quantity, not the quality, of these proteins.

Variation in composition of sweet corn with maturation - Peoria, IL. Grain of three varieties of hybrid sweet corn was harvested and analyzed at approximately 15, 30, 45, and 60 days after pollination. In all three varieties, percent protein content on a dry basis dropped markedly after 15 days post pollination but remained fairly constant at 12-13% during later development. Fat increased from 3 to 7 or 8% (dry basis) in all varieties. Lysine content decreased after 15 days but sulfur amino acids increased to a maximum at 60 days.

Variation in composition and quality of rice with thickness - New Orleans, LA. Starbonnet long-grain rough rice, which showed a Pearson Type III thickness frequency distribution curve, was fractionated by thickness into six fractions. Relationship between rough rice and brown rice thickness was linear. Analyses of the brown rices from the six fractions showed that protein, lipid, and crude fiber increased and the starch decreased with decreasing thickness. The density of the rough rice decreased with decreasing thickness. Milling tests showed that the percentage bran removal and the percentage breakage increased with decreasing thickness. The percentage of damaged kernels in the milled rice from the three thinner fractions was more than twice that of the thicker kernels. Percentage of chalky kernels also increased with decreasing thickness. The milled rice

lipid content increased with decreasing thickness while crude fiber values and cooking quality showed no essential differences. The data indicate that rice can be upgraded by removing the thinner fractions.

Hemicelluloses may influence cooking behavior of rice - New Orleans, LA. Evaluation of the effect of the addition of water soluble rice hemicelluloses on the viscosity, as measured by the Brabender Amylograph, of aqueous suspensions of rice flour suggest that these components may play a role in reducing the "stickiness" of cooked rice.

Variation in fatty acid composition of sorghum varieties - New Orleans, LA. Fatty acid profiles of five varieties of grain sorghum used in the breeding program at College Station, Texas revealed that, while the major acids were similar, the minor fatty acids varied considerably. Erucic acid was present in only one of the five varieties; arachidic acid and myristic acid were present in only two and behenic acid and lignoceric acid were both present in three of the five. These differences may prove useful as markers in breeding programs.

Effect of fertilizer on protein in pearl millet - New Orleans, LA. Protein and amino acid analysis of five hybrids grown in two replications at two levels of fertilization (12 and 120 lb./acre) in one crop year at Tifton, GA. showed a 50% increase in protein content at the higher level of fertilizer with no apparent lowering in quality of protein.

Variation in lipid profiles of the component parts of triticale, wheat and rye kernels - New Orleans, LA. Kernels of a triticale, wheat, and rye-grown at the same location in Alabama, were separated into their component parts (germ, bran, and endosperm) and analyzed free fatty acids and ten types of fatty acid-containing compounds. Marked differences were found in the contents of certain fatty acids. Large differences also were found in the content of certain polar lipids among the component parts of each cereal grain. For example, the lipids in the endosperm of triticale contained 15.2% phosphatidyl ethanolamine, while the germ lipids contained only 2%, and those of the bran contained none.

Relationship of lipid composition and age of triticale flours to baking characteristics - New Orleans, LA. Nine lipid-altered flours of triticale and two controls, prepared at SRRC, were sent to Alabama Agricultural and Mechanical University for evaluation. The amounts and types of polar lipids present affected baking performance and other characteristics. Storage of triticale flours at 64% relative humidity increased polar lipid content, decreased content of highly unsaturated fatty acids and increased loaf volume.



## FORAGE AND CROP RESIDUES

Effect of wilting on losses and saponin concentration of alfalfa - Albany, CA. Freshly harvested alfalfa wilted for 10-36 hours under controlled conditions of temperature, humidity and wind velocity, lost only 3-4% of dry matter as CO<sub>2</sub> as opposed to reported losses as high as 25%. The 50% apparent loss in saponin content on wilting suggests that gains with saponin sensitive animals should be as high with wilted alfalfa as that obtained with low saponin varieties.

Saponin content of alfalfa sprouts in commercial market - Albany, CA. Commercially grown alfalfa sprouts were found to contain levels of from 5-8% of biologically active saponins. Although the nature and identification of the saponins needs to be ascertained, there remains a question of consumer safety regarding general consumption of alfalfa sprouts.

Quantitative chemical evaluation of forage protein quality - Athens, GA. A systematic and comprehensive approach was developed utilizing Kjeldahl nitrogen, automated gel filtration and amino acid analysis for quantitatively evaluating forage protein quality. This approach was tested successfully on fresh and ensiled Coastal Bermudagrass where 70-77% of the crude protein was extracted. The quality of the protein extracted was described by the physical properties of solubility in 0.8 N NaCl, molecular distribution, amino composition, recoverable amino acid nitrogen and contamination of extracted protein by endogeneous compounds as indicated by relative changes in ultraviolet absorption.

Forage ultrastructure - Rumen bacteria relationships - Athens, GA. Tissues of warm-season forage grasses, which are lower in nutritive value compared to cool-season species, were shown to be more rigid and have a lower rate of digestibility. Studies suggest that rumen bacteria must adhere to tissue cells prior to the initiation of digestion and that the specific type of rumen bacteria adhering to the tissue varies with the tissue and the forage species. Rate of digestibility of a particular forage may therefore be dependent upon the relative concentration of different types of rumen bacteria.

Digestibility of forage fiber - Athens, GA. Previous work has demonstrated variability in digestibility of forage tissues by rumen bacteria. Lignin is thought to be the limiting factor. Current work with delignified tissues suggests that tissue (fiber) structure is equally important in determining rate and extent of digestibility.

Neutral carbohydrate content of crop residues - Peoria, IL. A wide variety of agricultural residues have been examined for their neutral carbohydrate composition. A number of residues contained between 15 to 30% xylose. The corn plant, with husks and cobs in the 30% range and stalks and leaves in the 20% range, is the best xylose-containing residue found to date.

Pith from stalks of corn, sorghum, sugarcane, and sunflowers were separated into holocellulose, hemicellulose A, hemicellulose B, and cellulose. Neutral sugar composition of these fractions is being determined.

Analytical methodology for evaluation of biomass potential - Weslaco, TX. Analytical techniques for total dry matter, total fermentable carbohydrates, fiber, and starch in sweet sorghums and in sugarcane, were evaluated and selected on the basis of suitability. A procedural manual was prepared detailing technologies adaptable to the limited analytical resources of collaborating Federal and State agencies in Louisiana and Florida. Department of Energy and Battelle Institute personnel are enthusiastic about the potential of sweet sorghum as a biomass crop.

#### MICROBIOLOGY

Important advance in knowledge of fungus morphology - Peoria, IL. For the first time, stages in the formation of the sexual spores in the fungus genus Zygorhynchus were examined by scanning and transmission electron microscopy. Warty material formed during spore development was found of value to identify species. Techniques developed in this work were used to examine seven of the 14 recognized families in the Mucorales and proved useful in showing inter- and intraspecific relationships.

Improved yeast identification procedures - Peoria, IL. Yeasts of such diverse importance to agriculture as those causing food spoilage and animal diseases were identified more accurately by new procedures involving chemical characterization of their deoxyribonucleic acid (DNA). Strains of Pichia believed to represent a single species when identified by traditional tests were shown to represent two species new to science once their DNA had been characterized. Results were further confirmed by demonstration of genetic incompatibility among the two species.

Nitrogen fixation and nomenclature of Actinomycetes studies - Peoria, IL. Representative strains of aerobic Actinomycetales, frequently touted as nitrogen-fixers, were tested using the acetylene reduction method for detection of potential for nitrogen fixation. None gave a positive result. A master list of streptomycete and streptoverticillia names was compiled to provide basis for selection of Approved Names in connection with the new starting date of January 1980 for nomenclature of bacteria.

New amylolytic Lactobacillus isolates acquired - Peoria, IL. Twenty-six amylolytic Lactobacillus isolates were collected. Production of strong amylolytic activity by Lactobacillus has rarely been reported. Moreover, preliminary characterizations suggest that these isolates may represent strains of a new species.



## SUGAR CROPS

Cause of carbonated beverage floc identified - New Orleans, LA. A troublesome flocculent precipitate that sometimes appears in carbonated beverages has been traced to the sugar. Floc was shown to result from an association at a concentration of parts per million between a polysaccharide and a protein contaminant from the cane. This association, however, requires a very specific proportion of the contaminants and the proper acidity to effect the charged interaction.

Isotope ratio analysis accepted as official AOAC method - Wyndmoor, PA. A collaborative study of four mixtures of honey and high fructose corn sirup, and one authentic honey has resulted in acceptance of the isotope ratio methodology as an official AOAC method, the first mass spectrometric method to qualify. Its use by Trade, FDA and U.S. Customs laboratories has identified about 20 samples as adulterated.

Two new assay procedures for honey adulteration - Wyndmoor, PA. Two test procedures in addition to the isotope ratio method have been developed. One procedure uses thin-layer chromatography and has the potential to detect corn sirup at lower levels than the isotope ratio test. The other test uses gas-liquid chromatography and will provide a reasonably effective screening method. Both procedures use commonly available, relatively inexpensive laboratory equipment and can be carried out in field laboratories. After the required collaborative testing, these methods will be available for use by regulatory agencies.

Impact of trash content on quality of sugarcane juices - Weslaco, TX. In seven pilot plant processing tests, no consistent correlation was found between quantities or types of trash milled and the clarities of crusher juices, or their nitrogen or ash contents.

Evaluation of new sorghum and sugarcane varieties - Weslaco, TX. From the data obtained, one new high-sucrose type sweet sorghum breeding line was selected for release as a commercial variety, and two sugarcane varieties were selected for superior performance on the various soils and under prevailing climatic condition in the Lower Rio Grande Valley of Texas.

## Technological Objective 2:

Reduce costs and improve markets for field crops through innovative and improved processing technologies that increase efficiency and pollution control, reduce energy requirements, optimize nutrient retention, and provide unique, improved, or equal product quality and safety.

### Research Locations:

Albany, California  
Athens, Georgia  
Peoria, Illinois  
New Orleans, Louisiana  
Corvallis, Oregon

### Selected Examples of Recent Progress:

TO 2

#### OILSEEDS

Evaluation of potato chips fried in sunflower (Southern) palm and cottonseed oils - Athens, GA. Chemical and flavor (taste panel) evaluation of chips fried in the various oils indicated no difference in the performance of the oils suggesting sunflower oil could be used interchangeably with a standard potato chip frying oil such as cottonseed oil. Flavor of stored chips from all oils gradually decreased in quality during storage at the same rate and differed significantly between chips stored at 0 and 10 weeks.

Improved utilization of defatted sunflower meal - Athens, GA. Research to date has shown that the quantity of lysine available for absorption in the ruminant can be significantly increased when the lysine is fed as a lysine-urea-formaldehyde polymer. Increasing the quantity of lysine available for absorption also significantly increases the efficiency of utilization of sunflower meal, protected from rumen degradation by formaldehyde, by presenting an improved balance of amino acids available for absorption and subsequent tissue protein synthesis in the growing animal.

Relative contribution of different hydroperoxides to the state of oxidation of soybean oil established - Peoria, IL. Quantitative GC-MS provided for the first time an answer to the basic question of what is the relative contribution of different hydroperoxides to the state of oxidation of soybean oil. At peroxide values above ten, linoleate contributed to the major part of the hydroperoxides; but at peroxide values below ten, linolenate was an important source of hydroperoxides. A different isomeric hydroperoxide composition was also found at low oxidation levels. These results suggest that the unique flavor deterioration of soybean oil at low oxidation levels may be caused by a different mechanism of autooxidation or decomposition of hydroperoxides.

Mechanism of natural antioxidant action in soybean oil studied - Peoria, IL. Autooxidation of soybean oil methyl esters in the presence of different concentrations of alpha tocopherol gave products containing a higher ratio of linoleate to linolenate hydroperoxides than the control sample. Therefore,



alpha tocopherol affects the cooxidation of linoleate and linoleanate in soybean esters. These studies have important implications with respect to the precursors of undesirable flavor compounds formed on oxidation.

Continuous, high pressure, copper-catalyzed hydrogenation of soybean oil - Peoria, IL. Soybean oils hydrogenated at high pressure in batch reactions were fractionated by high pressure liquid chromatography (HPLC) into diene, cis, and trans monoene products. Double bond analysis of these products showed that formation of positional isomers were suppressed to some extent by increased pressure and that hydrogenolysis to form alcohols did not occur.

Hydrogenations were performed in laboratory-scale high-pressure continuous hydrogenation system constructed from on-hand equipment using the same catalyst concentration and temperature employed in batch reactions. Pressures used were 100 and 200 psig. Total iodine value drop increased from 15 to 20 with the increase in pressure. Linolenate selectivity was about eight. Undesirable conjugated diene (0.4%) was still a measurable product of reaction at 200 psig ( $14.06 \text{ kg/cm}^2$ ), compared to 1-3% in commercial copper-hydrogenated oils.

Steam refining of soybean oil - Peoria, IL. Studies to evaluate steam refining as a potential alternative to alkali refining and its problems of pollution and energy consumption are continuing. Post degumming treatment with  $\text{H}_3\text{PO}_4$  and increased deodorization/deacidification times were investigated. Results showed that after three hours of deodorization good quality oils were obtained and free fatty acids were reduced to 0.07% compared to 0.15% FFA in oils deodorized for one hour. The experiments suggest that  $\text{H}_3\text{PO}_4$  treatment converts prooxidant iron to iron phosphates which are (1) removed by water degumming and washing following pretreatment or (2) inactive as prooxidants following post-treatment.

Effect of degumming parameters on removal of phospholipids from soybean oil - Peoria, IL. A single lot of commercially extracted crude soybean oil was degummed in the laboratory under batch conditions in which temperature, time, water concentration, and agitation were varied over a wide range. Data from 16 degumming runs indicate (1) time has a minor effect on removal of phosphatides, (2) there appears to be an optimum temperature ( $75^\circ\text{C}$ ) for degumming as measured by phosphorus removal, (3) the optimum water concentration is 2% by weight of the oil. Concentrations higher or lower gave low phosphorous removal and/or entrainment of oil in the hydrated gums, and (4) within experimental error agitation has no effect on phosphatide removal.

Removal of metal-complexing phytates from soybeans - Peoria, IL. Dietary phytate is reported to chelate with several mineral elements, and thereby reduces the availability of these minerals in the intestinal tract. Results show that the phytate in soybeans can be easily removed by soaking in water. The finding also demonstrates the benefit of a simple soaking process in preparing soybean foods.

Fluorometric technique under evaluation as a rapid method for estimating the quantity of soy products in meat: soy mixtures - Peoria, IL. Preliminary reports from the U.S. Army Natick Development Center indicated that soybean products contain materials that fluoresce at 440 nm and that fluorescence measurements can be used to estimate the amount of soy in meat:soy mixtures. The technique is currently being evaluated for possible use by FNS to monitor beef:soy purchases for the National school Lunch.

Mechanism of soybean phosphatidylcholine (SPC) oxidation - Peoria, IL.

Data suggest that oxidized phospholipids contribute to the bitter taste in soy protein products. Understanding the mechanisms of this oxidation is, therefore, important. A partially purified mixture of lipoxygenase isoenzymes prepared from raw defatted soybean meal is capable of oxidizing free and esterified polyunsaturated fatty acids in the normal pH range of 6.0 to 8.5. With SPC as the substrate, however, oxidation occurs only above pH 9. During oxidation, about 2% of the polyunsaturated fatty acids in SPC were converted to oxygenated forms that were chromatographically similar to those present in bitter-tasting phospholipids isolated previously. An active peroxidase capable of utilizing fatty acid hydroperoxides was detected in the isoenzyme preparation.

Composition of neutral lipid fraction associated with soy protein isolate found to differ widely from neutral lipid of hexane extractable oil - Peoria, IL.

The neutral lipid fraction isolated from alcohol extracts of soy isolates by column chromatography was found to consist of 14% triglycerides, 65% diglycerides and 21% monoglycerides. Residual lipids are thought to affect functional properties of isolates including flavor.

Continuous flow solubilization of soy proteins in isolate preparation -

Peoria, IL. In initial laboratory scale studies, sonification was found to solubilize soy proteins more effectively than with ordinary mixing equipment. An ultrasonic cell has now been set up to investigate the process on a scaled-up continuous flow basis. Preliminary tests show that soy flakes can be efficiently peptized in a fraction of a second in a continuous sonifier cell. Optimization of parameters, improvements in process efficiency, and cost analysis remain to be worked out.

Development of immobilized enzyme hydrolysis system for complex carbohydrates in oilseed products - Peoria, IL. Procedures for pilot-plant production of the mixed enzyme extract of alpha-galactosidase and invertase from Aspergillus awamori NRRL-4869 were developed. Ratio of alpha-galactosidase to invertase varied with enzyme production procedures. Kinetics of the mixed enzyme system were examined and a model developed that appears to adequately explain the reaction. A hollow-fiber reactor and its components were assembled and shown to be operable. Computer simulation of the process shows that in certain cases, the current design is more efficient in the hydrolyses of raffinose than previous design.

Use of peanut flour in food blends - Peoria, IL. The effect of substituting peanut flour for soybean flour in various Public Law 480 food blends was studied. The flavor of the blends with peanut flour was acceptable. Storage stability of the blends containing peanut flour were not quite as good as those containing soybean flour as evidenced by slightly higher peroxide values. PER values of the peanut blends were considerably lower than those of the corresponding blends containing soybean flour, but could be increased to about 2.0 either by the addition of L-lysine HCl or soy flour. Stability and nutritional results suggest that satisfactory blends can be produced with peanut substituted for part or all of the soybean flour.



Development of blended food formulations - New Orleans, LA. Blended food formulations were compiled using cottonseed protein concentrate in combinations with soy flour, corn meal, whey protein concentrates, wheat protein concentrates and lysine hydrochloride. The best blends, based on FAO amino acid scores, were determined by computer analysis.

Correlation of volatile composition and quantity with soybean oil quality - New Orleans, LA. Data from a series of experimental soybean oils obtained by direct gas chromatography gave correlation coefficients of 0.99 with flavor scores obtained by 150 AOCS panelists and the logarithm of the contents of trans-2-heptenal, trans-2, trans-4-heptadienal, trans-2, cis-4-decadienal, trans-2, trans-4-decadienal, and total volatiles. AOCS collaborative studies are planned.

Color components in cottonseed protein products - New Orleans, LA. Chemical and spectral analyses of water soluble, low molecular weight constituents indicates that quercetin glycosides contribute to the yellow color of cottonseed flour.

Computer model developed for predicting functional properties of cottonseed products - New Orleans, LA. An empirical multiple linear regression model describing emulsion and foaming properties (capacity, viscosity) as a function of pH and suspension concentration was developed and can be used to predict the effect of suspension pH and percent protein on functional properties of cottonseed products.

Preparation and evaluation of textured vegetable protein products from cottonseed flour (contract Texas A&M Univ.) - New Orleans, LA. Pre-extrusion pH adjustment of the mix in the range of 4.5 to 9.5 showed that there is a trend toward greater puffing and lower bulk density of the extrudates as the pH of the extrusion flours is made more alkaline. Extrusion investigations have shown that cottonseed and soy flours respond in different manner to extrusion technology.

The proximate analyses, amino acid profiles and available lysine assays on LCP flour, glandless flour and the textured food products made therefrom showed that nutritional quality is not affected during texturization and processing.

Fabricated foods such as chilies, patties, and loaves made with 25% textured flours were compared with all-meat products by an internal screening test and consumer test. Unseasoned all-meat products had significantly higher acceptance than corresponding textured cottonseed products. However, there was no significant difference if the products were seasoned.

Production of edible cottonseed flour from glanded seed by air classification - New Orleans, LA. With proper conditions of desolventization and grinding of defatted flakes it was possible to prepare a cottonseed flour with 0.045% free gossypol from Mississippi, Texas and California seed. Free gossypol content of flour made under batch extraction conditions was lower than that from continuous extraction.



Solvent - interization of peanut oil - New Orleans, LA. In the evaluation of various solvents for the preparation of a peanut oil that will not solidify at refrigerator temperature and meet commercial requirements for use as a salad oil 2-butanone had best performance characteristics, i.e., low dissolving power for crystals and complete miscibility with the liquid oil at all temperatures and concentrations.

Random rearrangement, directed rearrangement, long crystallization time, dilute solutions and removal of unsaponifiables all failed to improve the use of fractionation.

## GRAINS

Stabilization of rice bran increases nutritional energy value by 25 percent - Albany, CA. This ~~sizable~~ increase in nutritional energy value compared to that of unstabilized bran should increase feed value and utilization of rice bran by a similar quantity.

Cheese whey used as extraction medium in the preparation of protein concentrates - Albany, CA. Cheese whey, a waste byproduct, when used to prepare protein concentrates from wheat shorts, rice bran and soy flour provided products with improved nutritional quality and lower process energy requirement.

Homology among storage proteins of wheat - Peoria, IL. Subunits of omega - gliadin, high-molecular weight gliadin, and ethanol-soluble glutenin were successfully sequenced and exhibited considerable homology among proteins in each fraction. The high-molecular weight gliadin and ethanol-soluble glutenin subunits were shown to be closely related and possibly identical based on partial sequence analysis.

Further characterization of native glutenin - Peoria, IL. Chromatography of purified native glutenin on agarose gel filtration columns in the presence of sodium dodecyl sulfate on sodium stearate solutions separated low-molecular weight proteins from the predominant high-molecular weight materials. These results are in agreement with current views that some glutenin subunits are bound to the high-molecular weight disulfide linked proteins solely by hydrophobic bonds rather than through covalent links.

Interactions between food gums and wheat starch - Peoria, IL. The gelatinization properties of wheat starch and soft wheat flour were altered in the presence of some polysaccharide gums. Both xanthan and guar gum were shown to increase the solubility and paste viscosity of wheat starch when heated in dilute suspensions. The normal retardation of starch granule swelling in the presence of margarine and sugar were partially overcome when these gums were added. The increased viscosity permits development of a binder matrix that can substitute for the oil-in-water emulsion and soft wheat flour protein in dessert cakes.

High protein, gluten-free breads - Peoria, IL. In gluten-free breads wherein a food gum-starch matrix replaces the function of gluten, the starch was replaced in a range of 25 to 50% with either oilseed protein flours or cereal meals and flours. The loaf volume and texture of baked products fortified with soy, peanut, cottonseed, and corn germ flours were correlated with protein solubility, pentosan content, and extent of starch gelatinization during baking. The wide variety of textures obtained and the simple method of dough preparation indicate possibilities for commercial development.

New protein products from soft wheats - Peoria, IL. High-protein fractions produced by air classification of high protein soft wheats were successfully used to produce protein-rich isolates and starch.

High-protein fractions from high-lysine sorghum flour - Peoria, IL. High-lysine sorghum was Buhler-milled into flour and shorts. The flour was finely ground and air classified. The protein content of the air-classified fractions ranged from 6.6 to 50.1% compared with 9.9% for the starting flour. The combined high-protein fractions had 18% protein and accounted for 18% of the flour and 32% of the total flour protein.

New analytical procedures for dietary fiber constituents - Peoria, IL. Simpler and shorter procedures were found for analyzing the sugars of fiber polysaccharides by the alditol acetate gas-liquid chromatographic method. A new colorimetric method for determining sugar acids, including glucuronic acid, was developed.

Functional and nutritional properties of edible wet-milled corn germ flour - Peoria, IL. Flour from wet-milled corn germ contains 30% protein with 5.9% lysine and a good balance of other essential amino acids. Rat assay shows that the flour has a protein efficiency ratio of 2.4 normalized to a PER of 2.5 for casein. The flour typically contains 26% pentosans, 12% cellulose, and 0.6% lignin. It also contains about 18% starch, 0.5% fat, and 2% ash. The flour has a water-binding capacity of 7.4, a protein dispersibility index of 32%, a flavor similar to a "good" soy flour, but has poor fat-binding ability.

Dry-milling characteristics of "trickle ammonia" preserved corn - Peoria, IL. Dry milling of corn picked at high moisture and subjected to NRRC "trickle ammonia" plus ambient air drying process resulted in yields of milled products similar to those obtained from the milling of heated air drying. Essentially, no water-extractable ammonia (0.007%) was present in the grits. Germ fraction contained 0.2% residual ammonia.

New processing system for wild rice tested (contract University of Minnesota) - Peoria, IL. Plant size prototypes of air stream separator developed under contract by the University of Minnesota were successfully operated at two wild rice plants during the 1977 processing season. The heavy, more mature rice was taken directly from the separator to the parcher without any fermentation. Satisfactory processing followed, yielding a final rice product equal to that obtained by the older, longer process.



Parching of wild rice - Peoria, IL. Several approaches to the wild rice parching process were studied. Criteria for good parching included yield of products and amount of breakage resulting from subsequent processing of the parched rice. Direct drying of green rice gave high breakage. Autoclaving wild rice and then drying it with hot air decreased breakage due to the positive effect of steaming. Steaming appeared to toughen kernel, as well as eliminating white centers. Use of microwave to carry out internal steaming followed by hot air drying gave similar results.

Preparation of brown rice flour from "thin" rough rice - New Orleans, LA. The economic viability of the procedure for upgrading rough rice quality by removing thinner fractions requires the development of acceptable use for the "thin" fraction. A coarse flour was produced with one pass through a Kolloplex pin mill. Additional passes (up to 5) progressively produced finer flour in the 44-63  $\mu$ m range. The Pallman mill produced a finer mesh flour. One pass was sufficient to produce a flour with 93% below 63  $\mu$ m. The indications are that these mills can be used to produce a wide particle size range of brown rice flours suitable for producing new products from the thinner rice fractions.

#### FORAGE AND CROP RESIDUES

Pro-Xan process to conserve energy and produce a food protein concentrate from alfalfa improved - Albany, CA. Innovations in processing have led to increases in yields of whole leaf protein (Pro-Xan) to about 18% (dry basis) as compared with 12% achievable two years ago. Use of separately harvested plant tops or leaves increases yield to 20-25%. Economic evaluations show good feasibility even at 15% yields with respect to energy conservation and cost when compared to normal dehydration. A commercial plant is in operation in France and an American plant will be built and evaluated by a commercial firm, with the cooperation of WRRRC and DOE (Department of Energy).

Yields of edible leaf protein concentrate (LPC) increased - Albany, CA. Research on white edible grade LPC has increased pilot plant yields to over 5% (dry basis). Laboratory preparation of soluble forms of white LPC has been successful. Such products have properties for incorporation in foods superior to previous products but further work is needed on flavor and color problems.

New, free-flowing, high-fat feed product from alfalfa juice - Albany, CA. Free-flowing dry products containing up to 40% fat or oil have been obtained by emulsifying the fat in alfalfa juice, coagulating the protein with steam, and drying the dewatered coagulum. Such products can be incorporated into mixed feeds without the use of special handling equipment.

Yield of leaf and seed protein from several subtropical and tropical species - Albany, CA. Plants were harvested at 11 weeks for leaf protein and, in the case of Amaranthus species, at 16 weeks for seed protein. Production of leaf protein varied from 450 to 1250 lb./acre. Amaranthus was the highest. Seed protein yield varied from 115 to 230 lb./acre.

Partially hydrolyzed alfalfa saponins five times as effective in preventing cholesterol absorption in primates - Albany, CA. This finding makes the isolation and use of the partially hydrolyzed alfalfa saponin for treating hypercholesterolemia in monkeys, and potentially in man, economically practical.

Improved understanding of pathways to upgrade straw for feed use - Albany, CA. It has been demonstrated that improved digestibility of cereal straws can be accomplished by treatment with alkali or with a powerful delignifying agent-like peroxyacetic acid. The results indicate that not all cellulosic wastes respond uniformly to a particular treatment, and that each waste must be investigated individually to maximize the digestibility increase.

Characterization of forage lignin structure - Athens, GA. Comparison of carbon-13 nuclear magnetic resonance spectra of model compounds (coniferin and 4-O-methyl umbelliferoyls) with spectra of lignin and lignin-carbohydrate complexes (LCC) of forage grass cells have shown certain similarities particularly in that area of the spectra specific for ester linkages. There also is a spectral similarity between the LCC and coniferin for the ether linkage. But other comparisons which would match do not. Further studies with model compounds, therefore, are required.

Protein concentrate from white clover - Athens, GA. Through a fractionation procedure, a green-colored powder containing 50% crude protein was obtained from white clover. This protein concentrate is suitable as a protein supplement in poultry and swine feed. The fibrous residue left after the protein was extracted contained ample protein (approx. 8%) to be used as a ruminant (cattle) feed.

Utilization of peanut hulls - Athens, Ga. Starter cubes made from peanut hulls were observed to inhibit seed germination (e.g., tomatoes). Washing (aqueous) or steaming (heating) the hulls was shown to eliminate the inhibitors thus permitting the use of peanut hulls to replace the more costly sphagnum peat moss in commercial starter cubes.

New in vitro methodologies for cellulose materials - Peoria, IL. A new chemical procedure (DMSO-paraformaldehyde) that is shorter than enzyme-digestibility methods was developed and found suitable for evaluating "available" cellulose, i.e., digestibility of crop residues. A semi-quantitative method for selecting plate-grown colonies in the selection of mutants having greater or less cellulase capacity has been developed.



Semisolid fermentation process for production of animal feed from agricultural residues - Corvallis, OR. Unacceptability of fermented straw was traced to the sulfur and was corrected by substitution of hydrochloric or phosphoric acid for sulphuric acid used in hydrolyzing the straw, and by fermenting with Aureobasidium pullulans instead of Candida utilis, which greatly increased uptake by voles. Feeding trials with sheep are planned.

## MICROBIOLOGY

USDA-SEA/Federal Research (FR) Culture Collection - Peoria, IL. Responsibilities to acquire, maintain and distribute cultures and information were continued. As of January 1, 1978, the Collection maintained 57,411 strains of molds, yeasts, bacteria, actinomycetes and algae.

Acquisition of N.R. Smith Bacillus was completed. Accessioning into the ARS Collection ensures that the Bacillus collection will be perpetuated and will continue to serve as a source of authentic Bacillus cultures for research throughout the world. During 1977, the Collection distributed 3,087 cultures of which 1,986 were sent to investigators in the United States and 1,101 were sent abroad.

Carbon assimilation and fermentation data on cultures in the yeast collection computerized - Peoria, IL. A computer program was developed and data from about 1,400 strains of yeast have been entered.

## SUGAR CROPS

New intense sweetener - Peoria, IL. An intensely sweet compound, sweeter than saccharin, which contains neither nitrogen nor sulfur, was obtained by mimicking the structure of phyllodulcin, a naturally occurring sweetener found in the leaves of certain species of hydrangea plants. Although this particular compound is subject to hydrolysis in water and therefore may not serve as a replacement for saccharin, the successful synthesis shows that compounds can be designed to illicit a specific taste response.

New starch derivatives prepared with immobilized amylases - Peoria, IL. It is generally recognized that immobilization of some enzymes alters their kinetic, operating, and stability parameters. Little attention has been paid to the effect of the carrier on the magnitude of these parameters and its mechanism. It has now been shown that  $\alpha$ -amylase immobilized on porous glass has properties different from the same enzyme immobilized on phenol-formaldehyde resin. The former hydrolyzes amylose and amylopectin with equal facility, while the latter attacks amylopectin very slowly even though amylose is readily degraded. This approach to the study of immobilized enzymes opens the possibility of using such enzymes to prepare polymeric derivatives that would be difficult or impossible to prepare in any other manner.

Characterization of dextranases - Peoria, IL. Dextranases, like amylases, exist in multiple types. Some split only  $\alpha$ -1,6 bonds, while others split both  $\alpha$ -1,6 and  $\alpha$ -1,3. Some act as endolytic enzymes and split internal bonds of the dextran molecule while others act exoenzymically and remove either glucose or isomaltose from chain ends. In order to assess the impact of immobilization on dextranase pattern of action, it is necessary to prepare and characterize various dextranases. The pattern of action of soluble dextranases from Penicillium funiculosum and P. lilacinum when tested on NRRL B-512F dextran, indicates they are typical endoenzymes.



PUBLICATIONS

OILSEEDS

TO 1

Athens, Georgia

Chapman, G. W. and J. A. Robertson. Changes in phospholipid levels during high moisture storage of soybeans. JAACS 54:195-198. 1977.

Peoria, Illinois

List, G. R. and G. F. Spencer. Fate of Jimsonweed Seed Alkaloids in Soybean Processing. J. Am. Oil Chem. Soc. 53:535. 1976.

List, G. R., C. D. Evans, K. Warner, R. E. Beal, W. F. Kwolek, L. T. Black and K. J. Moulton. Quality of Oil from Damaged Soybeans. J. Am. Oil Chem. Soc. 54:8-14. 1977.

Wolf, W. J. Legumes: Seed composition and structure processing into protein products and protein properties. IN Food Proteins, Chapter 10, J. R. Whitaker and S. R. Tannenbaum (eds.), AVI Publishing Co., Inc., Westport, Conn. 1977.

New Orleans, Louisiana

Cherry, J. P., J. G. Simmons, and J. D. Tallant. Cottonseed Protein Composition and Quality of Gossypium Species and Cultivars. Proc. Beltwide Cotton Product Res. Conf. 31:46-49. 1977.

TO 2

Albany, California

Friedman, M. Effects of lysine group modification on chemical, physical, nutritive and functional properties of proteins. IN "Food Protein," J. R. Whitaker and S. R. Tannenbaum (eds.), AVI Publishing Co., Westport, Conn. 1977. Pp. 446-483. 1977

Friedman, M. and G. A. Broderick. Protected proteins in ruminant nutrition. In vitro evaluation of casein derivatives. IN "Protein Crosslinking: Nutritional and Medical Consequences," M. Friedman (ed.), Plenum Press, N.Y., Advances in Experimental Medicine and Biology, 86B:545-558. 1977.

Athens, Georgia

Goodin, P. L. Striking oil with sunflowers. Agriculture Research 25(9):6-7. March 1977.

Robertson, J. A., W. H. Morrison, III and B. G. Lyon. Sunflower seed and oil utilization research. Proc. Sunflower Forum, Fargo, N.D., Volume 2, pp. 4-6, January 12-13, 1977.

Robertson, J. A. and W. H. Morrison. Effect of heat and frying on sunflower oil stability. JAOCS 54:77A-81A. 1977.

#### Peoria, Illinois

Drozdowski, B. and Zajac, M. Effect of concentration of some nickel catalyst poisons in oils on the course of hydrogenation. J. Am. Oil Chem. Soc. 54:595. 1977.

Drozdowski, B. Effect of unsaturated acyl position in triglycerides on the hydrogenation rate. J. Am. Oil Chem. Soc. 54:600. 1977.

Eldridge, A. C., K. Warner, and W. J. Wolf. Alcohol treatment of soybeans and soybean protein products. Cereal Chem. 54:1229-1237. 1977.

Elson, C. E., N. J. Benevenga, D. J. Canty, R. H. Grummer, A. E. Johnston, J. J. Lalich, J. R. Porter, J. Rapacz, and E. S. Shrago. trans-Fat: Possible atherogenic properties of trans-unsaturated fatty acids. 1976 Annual Report, Food Research Institute, University of Wisconsin, Madison, Wisconsin, 401-414. 1977.

Frankel, E. N., W. E. Neff, W. K. Rohwedder, B.P.S. Khambray, R. F. Garwood and B.C.L. Weedon. Analysis of autoxidized fats by gas chromatography-mass spectrometry. I. Methyl Oleate. Lipids 12:901-907. 1977.

Frankel, E. N., W. E. Neff, W. K. Rohwedder, B.P.S. Khambray, R. F. Garwood, and B.C.L. Weedon. Analysis of autoxidized fats by gas chromatography-mass spectrometry. II. Methyl Linoleate. Lipids 12:908-913. 1977.

Frankel, E. N., W. E. Neff, W. K. Rohwedder, B.P.S. Khambray, R. F. Garwood, and B.C.L. Weedon. Analysis of autoxidized fats by gas chromatography-mass spectrometry. III. Methyl Linolenate. Lipids 12:1055-1061. 1977.

Gardner, H. W., R. Kleiman, D. Weisleder, and G. E. Inglett. Cysteine adds to lipid hydroperoxide. Lipids 12:655-660. 1977.

Gardner, H. W. and R. Kleiman. A soy extract catalyzes formation of 9-oxo-trans-12, 13-epoxy-trans-10octadecenoic acid from 13-hydroperoxy-cis trans-11-octadecadienoic acid. Lipids 12:941-944. 1977.

Gardner, H. W. and D. J. Sessa. Degradation of fatty acid hydroperoxide by cereals and a legume: A Comparison. Proc. 13th World Congress Int. Soc. Fat. Res. Symp. 10:35-43. 1977.

Garwood, R. F., B.P.S. Khambray, B.C.L. Weedon, and E. N. Frankel. Allylic hydroperoxides from autoxidation of methyl oleate. J. Chem. Soc. Chem. Commun. 364-365. 1977.

Kanda, Hiroshi, Hwa L. Wang, and C. W. Hesseltine. Method for producing soybean milk yoghurt. U.S. Patent 4,066,792. January 3, 1978.

Koritala, S. Selective hydrogenation of soybean oil VIII. Effect of method of preparation upon the activity of a copper-silica catalyst. J. Am. Oil Chem. Soc. 54:267. 1977.

List, G. R. Atomic absorption flashback. J. Am. Oil Chem. Soc. 54:677A. 1977.

List, G. R., E. A. Emken, W. F. Kwolek, T. D. Simpson, and H. J. Dutton. "Zero trans" Margarines: Preparation, Structure and Properties of Interesterified Soybean Oil-Soy Trisaturate Blends. J. Am. Oil Chem. Soc. 54:408-413. 1977.

Mounts, T. L., H. J. Dutton, C. D. Evans, and J. C. Cowan. Chick edema factor: removal from soybean oil. J. Am. Oil Chem. Soc. 53:105. 1976.

Rackis, J. J. and R. L. Anderson. Mineral availability in soy protein products. Food Prod. Dev. 11:38, 40, 44. 1977.

Rackis, J. J. Soybean protein: uses, problems and potential. J. Am. Oil Chem. Soc. 54:290A, 292A, 294A. 1977.

Ramakrishnan, C.V., L. J. Parekh, P. N. Akolkar, G. S. Rao and S. D. Bhandari. Studies on soy-idli fermentation. Plant foods for man 2:15-33. 1976.

Schofield, C. R. and T. L. Mounts. New developments in silver resin chromatography of cis and trans fatty methyl ester. J. Am. Oil Chem. Soc. 54:319. 1977.

Selke, E., W. K. Rohwedder, and H. J. Dutton. Volatile components from triolein heated in air. J. Am. Oil Chem. Soc. 54:62-67. 1977.

Sessa, D. J. and J. J. Rackis. Lipid-derived flavors of legume protein products. J. Am. Oil Chem. Soc. 54:468-473. 1977.

Sessa, D. J., H. W. Gardner, R. Kleiman, and D. Weisleder. Oxygenated fatty acid constituents of soybean phosphatidylcholines. Lipids 12:613-619. 1977.

Sessa, D. J., H. W. Gardner, R. Kleiman and D. Weisleder. Oxygenated fatty acids from soybean phosphatidylcholines and their possible derivation from hydroperoxides. Proc. 13th World Congress Int. Soc. Fat Res. Symp. 10:45-61. 1977.

Stern, N., C. W. Hesseltine, H. L. Wang, and F. Konishi. Lactobacillus acidophilus utilization of sugars and production of a fermented soybean product. Can. Inst. Food Sci. Technol. J. 10:197-200. 1977.

Wolf, W. J. Physical and chemical properties of soybean proteins. J. Am. Oil Chem. Soc. 54:112A-117A. 1977.



New Orleans, Louisiana

Brown, M. L., J. I. Wadsworth, H. P. Dupuy, and R. W. Mozingo. Measurement of flavor quality of raw peanuts by direct gas chromatography, Peanut Science 4:54-56. 1977.

Cegla, G. P. and K. R. Bell. High pressure liquid chromatography for the analyses of soluble carbohydrates in defatted oilseed. J. Amer. Oil Chemist Soc., 54(4):150. 1977.

Cherry, J. P. Oilseed enzymes as biological indicators for food uses and application. IN "Enzymes in Foods and Beverage Processing," R. L. Ory and A. J. St. Angelo (eds.). ACS Symposium Series, Chapt. 12, pp. 209-228. 1977.

Dupuy, H. P., E. T. Rayner, J. I. Wadsworth, and M. G. Legendre. Analysis of vegetable oils for flavor quality by direct gas chromatography, J. Am. Oil Chemists Soc. 54:445-449. 1977.

Fisher, G. S., H. J. Zeringue, Jr., and R. O. Feuge. Surface activity of sucrose palmitates. J. Am. Oil Chemists Soc. 54:59-61.

Neucere, N. J., T. J. Jacks, and G. Sumrell. Interactions of globular protein with simple polyphenols. J. Ag. Food Chem. 26:214-216, 1978.

White, J. L., Sr., Z. Zarins, and R. O. Feuge. Some thermal properties of methyl malvalate, methyl sterculate, and their dihydro derivatives, J. Am. Oil Chemists Soc. 54:335-338. 1977.

GRAINS

TO 1

Albany, California

Autran, J. C., C. C. Nimmo, E. Lew and D. D. Kasarda. Relationships of rye and species of Triticum and Aegilops to common wheat (Triticum aestivum) as indicated by N-terminal amino acid sequencing of whole gliadin (prolamine) preparations. Abstract in Cereal Foods World. 22(9):478. 1977.

Becker, R., R. M. Saunders and K. Lorenz. Saccharides of maturing triticales, wheat and rye. J. Ag. Food Chem. 25:1115-1118. 1977.

Betschart, A. A., R. Y. Fong, and R. M. Saunders. Rice milling byproducts: Comparative extraction and precipitation of nitrogen from U. S. and Spanish bran and germ. J. Food Sci. 42:1088-1093. 1977.

Caldwell, K. and D. D. Kasarda. Comparison of electrophoretic patterns of albumins and globulins of species related to bread wheats. Abstract in Cereal Foods World. 22(9):475. 1977.

Peoria, Illinois

Anderson, R. A., H. F. Conway, and L. H. Burbridge. Yield and Chemical Composition of Fractions from Dry Milling of a High-Lysine Grain Sorghum. Cereal Chem. 54:855-856. 1977.

Paulis, J. W. and J. S. Wall. Comparison of the Protein Compositions of Selected Corns and Their Wild Relations, Teosinte and Trypsacum. J. Agric. Food Chem. 25:265-270. 1977.

Tallent, W. H., R. A. Anderson, and T. L. Mounts. Seeds of Hope for Food Gains from Grains. Proc. Natl. Food Loss Conf., Boise, Idaho, September 12-15, 1976, pp. 17-29.

0 2

Albany, California

Cole, E. W. and H. Ng. Two-dimensional SDS-gel electrophoresis studies on the wheat flour gel protein subunits. Abstract in Cereal Foods World 22(9):480. 1977.

Fullington, J. G., E. W. Cole and D. D. Kasarda. Quantitation of wheat protein subunits by densitometry of gel electrophoretic patterns. Abstract in Cereal Foods World. 22(9):480. 1977.

Kasarda, D. D. The relationship of wheat proteins to celiac disease. Abstract in Cereal Foods World. 22(9):460. 1977.

Lindsay, G. W., Saunders, R. M. and G. O. Kohler. Preparation and nutritional quality of protein concentrates from wheat shorts, rice bran and soy flour by extraction with cheese wheys. J. Food Sci. 42:1365-1369. 1977.

Mecham, D. K. Modified procedures for gel electrophoresis of gliadins. Abstract in Cereal Foods World. 22(9):480. 1977.

Saunders, R. M. Potential food-grade materials from rice. Intern. Rice Commission Newsletter, FAO

Saunders, R. M. and G. O. Kohler. Preparation of stable protein concentrates from grain products and whey. U. S. Patent No. 4,064,283.

Sugihara, T. F. Nontraditional fermentations in the production of baked goods. Baker's Digest. 5:76, 78, 80, 142. 1977.

Peoria, Illinois

Anderson, R. A. and G. N. Bookwalter. Sorghum Utilization Research at the Northern Regional Research Center. Sorghum Newsl. 20:101-102. 1977.

Bietz, J. A., F. R. Huebner, J. E. Sanderson, and J. S. Wall. Wheat gliadin homology revealed through N-terminal amino acid sequence analysis. Cereal Chem. 54:1070-1083. 1977.

Bookwalter, G. N. Corn-based foods used in food aid programs: Stability Characteristics--A Review. J. Food Sci. 42:1421-1427. 1977.

Bookwalter, G. N., K. Warner, and R. A. Anderson. Fortification of dry-milled sorghum with oilseed proteins. J. Food Sci. 42:969-973. 1977.

Frank, J. F., E. H. Marth, R. C. Lindsay, and D. B. Lund. Microorganisms and flavor development associated with the wild rice fermentation. J. Milk Food Technol. 39:600-613. 1976.

Huebner, F. R. Wheat flour proteins and their functionality in baking. Bakers' Dig. 51:25-31, 154. 1977.

Huebner, F. R., Bietz, J. A. and J. S. Wall. Disulfide Bonds: Key to wheat protein functionality. IN: Adv. Exp. Med. Biol. 86A. Protein crosslinking: biochemical, medical, and nutritional consequences. M. Friedman (ed.), Plenum Press, New York, pp. 67-68. 1977.

Lund, D. B., R. Heidemann, R. C. Lindsay, C. E. Johnson, E. H. Marth and D. A. Stuiber. Extended storage of wild rice. Trans. ASAE 19:332-336, 340.

Nielsen, H. C., J. S. Wall, J. K. Mueller, K. Warner and G. E. Inglett. Effect of bound lipid on flavor of protein isolate from corn germ. Cereal Chem. 54:503-510. 1977.

Stringfellow, A. C., O. L. Brekke, V. F. Pfeifer, L. H. Burbridge, and E. L. Griffin. Fractionation of defatted wheat and corn germ by air classification. Cereal Chem. 54:415-428. 1977.

Wu, Y. V., K. R. Sexson and J. S. Wall. Tritcale protein concentrate: preparation, composition, and properties. J. Agric. Food Chem. 24:511-517. 1976.

Wu, Y. V., K. R. Sexson, J. E. Cluskey and G. E. Inglett. Protein isolate from high-protein oats: preparation, composition, and properties. Triticale for Food Uses. J. Food Sci. 42:1383-1386. 1977.



## SUGAR CROPS

TO 2

### New Orleans, Louisiana

Carpenter, F. G., M. A. Clarke. Decolorization. Cane Sugar Handbook, Chapter 19, pp. 455-493. Wiley, 1977.

Clarke, M. A. and F. G. Carpenter. Special Techniques for Analysis of Sugars and Nonsugars. Cane Sugar Handbook, Chapter 37, pp. 734-760, Wiley, 1977.

Godshall, M. A., M. A. Clarke, E. J. Roberts and F. G. Carpenter. Soluble Silicates in Refinery Processes. Proc. Sugar Industry Tech. 35:58-67. 1977.

### Wyndmoor, Pennsylvania

Doner, L. W. The Sugars of Honey--A Review. J. Sci. Food Agr. 28: 443-456. 1977.

Doner, L. W. and J. W. White, Jr. Carbon-13/Carbon-12 Ratio is relatively uniform among honeys. Science, 197:891-892. 1977.

White, J. W., Jr. Developing tests to detect honey adulteration. American Beekeeping Federation Meeting, San Antonio, TX, January 24-28. 1977.

White, J. W., Jr. Sodium-potassium ratios in honey and in high-fructose corn sirup. Bee World, 58:31-35. 1977.

White, J. W., Jr. Specific determination of sucrose in honey. J. Assoc. Offic. Anal. Chemists, 60:669-672. 1977.

White, J. W., Jr. Developing tests to detect adulteration of honey. American Bee Journal, 117:440-441. 1977.

## FORAGES

TO 1

### Albany, California

Livingston, A. L., R. E. Knowles, Adolfo Amella and G. O. Kohler. Nutrient changes during alfalfa wilting and dehydration. J. Agric. Food Chem. 25:779-783. 1977.

Athens, Georgia

Akin, D. E., E. L. Robinson, F. E. Barton, II, and D. S. Himmelsbach. Changes with maturity in anatomy histochemistry, chemistry and tissue digestibility of Bermudagrass plant parts. J. Agric. and Food Chem. 25:179-186. 1977.

Akin, D. E., E. L. Robinson and D. Burdick. Characterization of forage tissue by transmission and scanning electron microscopy. Proc. 34th Southern Pasture and Forage Crop Improvement Conference. Pp. 85-89. 1977.

Akin, D. E. and D. Burdick. Rumen microbial degradation of starch-containing bundle sheath cells in warm-season grasses. Crop. Sci. 17:529-533. 1977.

Albany, California

Bickoff, E. M., Donald DeFremery, Richard H. Edwards, Benny E. Knuckles, George O. Kohler, and Raymond E. Miller. Preparation of soluble edible proteins from leafy green crops. U.S. Patent No. 4,006,078. 1977.

Edwards, Richard H., Donald DeFremery, Bruce E. Mackey, and George O. Kohler. Factors affecting juice extraction and yield of leaf protein concentrate from chopped alfalfa. Trans. ASAE 20:423-428. 1977.

Kohler, George O. and Benny E. Knuckles. Edible protein from leaves. Food Technol. 31(5):191-195. 1977.

Kohler, G. O. and C. K. Lyon. Plant protein sources. IN "Food Proteins," Chapt. 20, J. R. Whitaker and S. R. Tannebaum (eds.). AVI Publishing Co., pp. 516-541. 1977.

Kuzmicky, Donald D. and George O. Kohler. Nutritional value of alfalfa leaf protein concentrate (Pro-Xan) for broilers. Poultry Sci. 56(5):1510-1516. 1977.

Kuzmicky, Donald D., A. Lyle Livingston, Richard E. Knowles, George O. Kohler, E. Guenther, O. E. Olson and C. W. Carlson. Xanthophyll availability of alfalfa leaf protein concentrate (Pro-Xan) for broilers and laying hens. Poultry Sci. 56(5):1504-1509. 1977.

Livingston, A. L., L. C. Whitehand and G. O. Kohler. Microbiological assay for saponin in alfalfa products. JAOAC. 60:957-960. 1977.

Lyon, C. K., D. A. Dinius and G. O. Kohler. In vitro evaluation of protected feeds for ruminants from alfalfa protein and safflower oil. J. Anim. Sci. 42:524-528. 1976.

Malinow, M. R., P. McLaughlin, L. Papworth, C. Stafford, G. O. Kohler, A. L. Livingston and P. R. Cheeke. Effect of alfalfa saponins on intestinal cholesterol absorption in rats. The Amer. J. Clinical Nutr. 30:2061-2067. 1977.

Malinow, M. R., P. McLaughlin, G. O. Kohler, and A. L. Livingston. Alfalfa saponins: A family of substances potentially useful for treating hypercholesterolemia. Clinical Res. 25:97-101. 1977.

Peo, E. R., Jr., A. L. Livingston, R. E. Knowles and G. O. Kohler. Effects of processing on the nutritional value of alfalfa meal. Proceedings 1977 Maryland Nutrition Conference, March 17-18, 1977.

#### Athens, Georgia

Albrecht, W. J. and R. R. Spencer. Processing Dehydrated Arrowleaf Clover. IN Proceedings of the Sixth Research-Industry Conference of Coastal Bermudagrass Processors' Association. Pp. 5056. 1976.

Amos, H. E., J. J. Evans, D. Burdick and T. Park. Degradation of Coastal Bermudagrass Protein by Rumen Microorganisms. Proceedings of the Sixth Research-Industry Conference of Coastal Bermudagrass Processors' Association. Pp. 80-88. 1976.

Barton, F. E., II and D. E. Akin. Digestibility of delignified forage cell walls. J. Agric. and Food Chem. 25:1299. 1977.

M. L. Fishman and Donald Burdick. Extractability, solubility and molecular size distribution of nitrogenous constituents in Coastal Bermudagrass. J. Agric. Food Chem. 25:1122-1127. 1977.

McHan, F., H. E. Amos and D. Burdick. Microbial treatment of Coastal Bermudagrass silage. IN "Proceedings of the Sixth Research-Industry Conference of Coastal Bermudagrass Processors' Association. Pp. 9-14. 1976.

McHan, F., R. Spencer, J. Evans and D. Burdick. The chemical composition of silage and haylage prepared from Coastal Bermudagrass. IN Proceedings of the 74th Annual Meeting of the Southern Association of Agric. Scientists (Dairy Sci. Section) 54:10. 1977.

Spencer, R. R. and H. E. Amos. In vitro Digestibility of chemically treated Coastal Bermudagrass. J. Anim. Sci. 45:126. 1977.

Spencer, R. R. Field wilting and chemical processing of Coastal Bermudagrass. IN Proceedings of the Sixth Research-Industry Conf. of Coastal Bermudagrass Processors' Assoc. Pp. 1-8. 1976.



## CROP RESIDUES

TO 2

### Albany, California

Dobie, John B. and Howard G. Walker, Jr. Effects of NaOH and  $\text{NH}_3$  on cubability and digestibility of rice straw. Transactions of the ASAE. 20:1018-1021. 1977.

### Athens, Georgia

R. A. Barford, J. Kupee and M. L. Fishman. Monitoring keratin degradation in activated sludge by rapid gel permeation chromatography. Journal WPCF 49:764-767. 1977.

Cheng, K. J., Akin, D. E. and Costerton, J. W. Rumen bacteria--their interaction with particulate dietary components and their response to dietary variation. Federation Proc. 36:193-197. 1977.

### Corvallis, Oregon

Grant, G. A., Y. W. Han and A. W. Anderson. Preliminary cost estimates for commercial fermentation of straw as animal feed. Biotech. Bioeng. 19:1817-1830. 1977.

Grant, G., Y. W. Han, A. W. Anderson, and K. L. Frey. Kinetics of ryegrass hydrolysis. Develop. Ind. Microbiol. 18:559-611. 1976.

Green, T. R., Y. W. Han and A. W. Anderson. A polarographic assay of cellulose activity. Annal. Biochem. 82:404-414. 1977.

Han, Y. W. and A. W. Anderson. Semisolid fermentation of straw. U. S. Patent No. 3,937,845. February, 1976.

Han, Y. W., J. W. Pence and A. W. Anderson. Process for improving the digestibility of hemicellulose-free straw. U.S. Patent No. 3,937,849. February, 1976.

## MICROBIOLOGY

TO 1

### Peoria, Illinois

Bothast, R. J. and K. L. Smiley. Metabolites of fungi used in food processing. IN Food and Beverage Mycology, L. R. Beuchat (ed.), Chapter 13, AVI Publishing Company., Westport, Conn. 1977.

DeMarini, D. M., C. P. Kurtzman, D. I. Fennell, K. A. Worden and R. W. Detroy. Transmission of PsV-F and PsV-S mycoviruses during conidiogenesis of Penicillium stoloniferum. J. Gen. Microbiol. 100:59-64. 1977.

Fennell, D. I. Aspergillus taxonomy. IN Genetics and physiology of Aspergillus, J. E. Smith and J. A. Pateman (eds.), Academic Press (London), pp. 1-21. 1977.

Kurtzman, C. P. Cephaloascus albidus A new heterothallic yeastlike fungus. Mycologia 69:547-555. 1977.

Nakamura, L. K. and D. D. Tyler. Induction of D-Aldohexoside:cytochrome c Oxidoreductase in Agrobacterium tumefaciens. J. Bacteriol. 129:830-835. 1977.

O'Donnell, K. L., J. J. Ellis, C. W. Hesseltine and G. R. Hooper. Zygosporogenesis in Gilbertella persicaria. Can. J. Bot. 55:662-675. 1977.

O'Donnell, K. L., J. J. Ellis, C. W. Hesseltine and G. R. Hooper. Azygosporogenesis in Mucor azygosporus. Can. J. Bot. 55:2712-2720. 1977.

O'Donnell, K. L., J. J. Ellis, C. W. Hesseltine and G. R. Hooper. Morphogenesis of Azygospores induced in Gilbertella persicaria (+) by Imperfect Hybridization with Rhizopus stoloniter (-). Can. J. Bot. 55:2721-2727. 1977.

Pridham, T. G. Fungi and bacteria. ARS Culture Collection. IN Systematic Collections of the Agricultural Research Service. BARC Symposium II Brochure Subcommittee, USDA Misc. Pub. No. 1343, pp. 1-2, 7-13. May, 1977.

Pridham, T. G. Contemporary species concepts in Actinomycetales. IN Actinomycetes: The Boundary Microorganisms. pp. 163-174. 1976.

Pridham, T. G. Identification of Streptomycetes and Streptoverticillia at the species level: Revision of 1965 System. IN Actinomycetes: The Boundary Microorganisms. pp. 175-181. 1976.

Pridham, T. G. Physiological characteristics and the species concept in Actinomycetales. IN Development in Industrial Microbiology, Vol. 18, pp. 287-297. 1977.

Pridham, T. G. and A. J. Lyons. Polyenic antifungal antibiotics: Systematics of Producers. IN Actinomycetes: The Boundary Microorganisms. pp. 373-541. 1976.

TO 2

Athens, Georgia

Cox, N. A., Frank McHan and A. J. Mercuri. Comparison of API, Minitex and conventional biochemical tests with some selected non-enterobacteriaceae. Proc. of the 74th Annual Meeting of the SAAS (Food Sci.), 14:25. 1977.

Cox, N. A., Frank McHan and D.Y.C. Fung. Commercially available minikits for the identification of enterobacteriaceae: A Review. J. of Food Protection. 40:866-872. 1977.

Peoria, Illinois

Szebiotko, K. and M. Piasecki. Isolation of thermophilic strains of microorganisms and elaboration of simple technological methods for utilization of cellulose for biosynthesis of single cell protein. First Technical Report, 1975-1976.



ANNUAL REPORT  
FY 1977

National Research Program 20530

TECHNOLOGIES FOR FOOD AND FEED USES - ANIMAL PRODUCTS

This is one of three National Research Programs in the area of food processing technologies. The program represents integrated basic and applied research on meat, poultry, dairy products and eggs, with goals of developing new products and processes and reducing marketing costs. Program objectives for reaching these goals are the development of new knowledge to insure that animal products are properly processed to retain or improve quality and nutritive value, and to identify and eliminate economic waste of nutrients and energy.

NPS Contact: M. J. Pallansch

PACS Contact: C. Golumbic

Technological Objective 1:

Reduce costs and improve markets for animal and poultry products by product innovation, increasing processing efficiency, reducing energy requirements, better nutrient retention and improved quality, storage, safety and pollution control.

Research Locations:

5102	Albany, California
7608	Winter Haven, Florida
7902	Athens, Georgia
3102	Peoria, Illinois
1104	Beltsville, Maryland
1402	Wyndmoor, Pennsylvania

Selected Examples of Recent Progress:

Meat:

Drying food materials by direct application of solar energy - Winter Haven, FL. Laboratory size direct heated solar dryers were designed and utilized to dry bovine paunch, a packing plant waste product.

Shortened drying periods for dry sausages using pale, soft exudative pork (PSE) - Athens, GA. After 7 days of drying, the sausage group containing PSE pork had significantly more shrinkage at each interval of drying than normal quality pork. Comparable dry states were obtained with PSE pork in 50-60 percent of the time required with normal pork.

Optimum conditions established for swine waste-corn fermentation - Peoria, IL. Final pH's attained with swine waste-corn fermentations were directly correlated with the percent fine corn particles (2.0 mm or less). Values of pH 4.2 can be attained when the percent fine particles exceeds 50%; this low pH was also correlated with a predominance of homofermentative lactic acid bacteria in the microbial population.

Biochemical changes identified in hot boned meats - Wyndmoor, PA. Initially, hot boned meat was tougher than conventionally processed meat, as measured by percent sediment, but this toughness decreased so that at ten days post slaughter there was no difference in the Warner-Bratzler shear tests. The higher tyrosine contents in hot boned meat suggest that tenderization of the hot boned meat results from increased proteolysis during aging. Hot boning had no effect on the ultimate pH and the creatinine content of the meat during storage, and generally resulted in a slower rate of bacterial growth during storage.

Methodology developed for the study of meat constituents using laser-Raman spectroscopy - Wyndmoor, PA. A laser Raman cell has been designed which eliminates the necessity for the laser beam to penetrate any substantial portion of the sample. High quality spectra are obtained and permit studies of the interactions of proteins and lipids in foods and feeds, including meat.

Ultrastructural changes in frozen beef muscle - Wyndmoor, PA. Meat tissue frozen at  $-18^{\circ}\text{C}$  shows minimal changes in ultrastructure as viewed by scanning electron microscopy (SEM), whereas drastic changes in fiber morphology occurred in meat frozen at liquid nitrogen temperatures ( $-196^{\circ}\text{C}$ ). Meat subjected to freeze-thaw cycles showed surface deterioration when thawed at room temperature ( $22^{\circ}\text{C}$ ) compared with meat thawed at refrigerator temperatures ( $4^{\circ}\text{C}$ ).

Tallow fractionation process optimized - Wyndmoor, PA. A bench scale continuous process has been set up for continuous tallow fractionation. The tallow oil fraction had high stability at  $0-5^{\circ}\text{C}$  storage. When protected with antioxidants, it had higher AOM stability than vegetable oil or vegetable-beef oil blends. The other principal product is a cocoa butter-like fraction having high potential in confectioneries.

#### Poultry:

Preservation of energy value of poultry chiller water - Albany, CA. Spin-chiller effluent waters from poultry processing were treated with magnesium sulfate-calcium hydroxide-calcium carbonate to flocculate suspended particles after screening to remove fat and gross particulates. The energy value of the water was reasonably well preserved for heat exchange purposes.

Drug uptake by dietary fibers measured - Albany, CA. Dietary fibers (acetone-dried) uptake of regularly prescribed drugs was studied in vitro to obtain direct information on fiber effects on drug absorption. An average of 76%, 74% and 25% of ethynyl estradiol, reserpine, and hydroxyprogesterone, respectively, were found absorbed onto the fibers.

Waste handling system for layer type chick hatchery automated - Athens, GA. The automated system delivered all hatchery waste via a pneumatic tube to a storage tank for rendering while expending only one-fourth labor as do manual methods.

Activated sludge waste treatment evaluated in commercial poultry processing - Athens, GA. Analysis of a pilot scale activated sludge treatment at a poultry plant indicated it was capable of removing 50% of the BOD<sub>5</sub> in waste water at hydraulic detention times as short as 1 hour.

Sand filters evaluated as advanced treatment of poultry processing lagoon effluent - Athens, GA. Studies have shown that sand filter beds could handle lagoon effluent at rates ranging from 0.25 MGAD (million gallons per acre per day) to 1.5 MGAD for up to one year without extensive labor for cleaning.

Poultry processing plant energy survey - Athens, GA. Fuel and electricity use at three processing plants indicated high rate for refrigeration and waste disposal. Annual electricity, natural gas, and fuel oil consumption per pound of product was determined.

Rancidity development is the principal deterrent to storage stability of poultry patties - Athens, GA. Panelists rating of stored poultry patties as "rancid" was confirmed by thiobarbituric acid values and reflects need for research on time-temperature relationships during storage and cooking.

Structured protein fiber (SPF) increases acceptability of poultry patties - Athens, GA. Addition of 25% SPF to mechanically deboned chicken meat increased the shear resistance, and were more chewy and desirable than patties with 15% SPF.

Polyphosphates benefit freeze-dried chicken - Athens, GA. The beneficial effects of rehydration, juiciness, and tenderness of freeze-dried chicken provided by addition of polyphosphates have been established under a cooperative project with the Natick Armed Forces Laboratories. Sensory defects traced to inadequate re-absorption and binding of water have been corrected by additions of 3% polyphosphates with or without salt. Quality improvement will encourage greater military and domestic consumption.

#### Dairy:

Calves gain weight with whey feed blocks - Beltsville, MD. Daily gains of calves on alfalfa hay and whey lick-blocks more than doubled when compared to those on alfalfa hay alone; gains also increased when orchard-grass feed was supplemented with whey blocks. The calves obtained 50-55% of their dry matter intake from the blocks.

Nutritional evaluation of whey and casein proteins in milk replacer feeding trials - Beltsville, MD. Feeding trials showed that whey protein milk replacer (MR) was equal to or better than commercial MR which used casein as the chief protein source; both formulas, however, lacked the nutritional value of whole milk. Suggested reasons for the inferior performance include undigested nitrogen-sugar complexes (heat damage) and a possible methionine deficiency in MR.



New lactose derivatives - Wyndmoor, PA. A general procedure was developed for the reductive amination of lactose and other reducing sugars. The lactityl-alkylamine offers potential as a chelating agent.

Simple, inexpensive methods developed for selective precipitation of whey proteins - Wyndmoor, PA. Precipitation procedures for whey proteins have been developed using various divalent cations including calcium, magnesium, zinc and copper, alone or in combination. Appropriate mixtures of magnesium acetate and calcium hydroxide result in almost complete precipitation of whey protein. The resulting precipitates contain about 20% protein, 20% lactose, and 50% ash.

Methodology developed for quantitation of whey proteins in fortified sausages - Wyndmoor, PA. An electroimmunoassay was developed for quantitating whey protein concentrates incorporated into frankfurters. The method utilizes antisera to the whey proteins,  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin. The method provides regulatory agencies the needed methodology for whey protein quantitation in sausages and other foods.

Cheddar cheese curing accelerated by enzymatic prehydrolysis of lactose - Wyndmoor, PA. Completed studies on the manufacture of Cheddar cheese from milk containing hydrolyzed lactose demonstrate that flavor and body development in the cheese is 2-3 months faster than in controls. This acceleration in curing time can save as much as 1.2¢/pound of cheese/month. In addition, the whey containing hydrolyzed lactose may find greater utility in ice cream manufacture or in the baking industry.

Xanthan gum produced from lactase-hydrolyzed cheese whey - Wyndmoor, PA. Xanthan gum yields of 9-14 g/L were obtained from lactase treated acid whey permeates. Glucose and galactose were utilized equally well by the Xanthomonas compestris with a fermentation efficiency of 50-60 percent.

Thermally regenerable resins used for whey permeate demineralization - Wyndmoor, PA. Sirotherm resins (developed by C.S.I.R.O., Australia) can be regenerated with hot water (90°C), thus avoiding the high cost and pollution problems associated with conventional acid-base regeneration. Permeate demineralization was accomplished in a two-step process. The demineralized permeates gave a 30 percent increase in yield of crystalline lactose.

Whey sirups produced from lactose - Wyndmoor, PA. High quality food grade sirups have been prepared from whey lactose suitable for use in baked goods and confectioneries. Application of either acid or enzymatic hydrolysis to whey and whey permeates results in sirups which, after concentration and purification, are to a great degree comparable to sucrose sirups. The process provides an additional utilization of an important cheese byproduct and should improve the economics of whey processing.

Iron bioavailability in fortified chocolate milk powders - Wyndmoor, PA. In vivo studies were utilized to evaluate the bioavailability of iron in two iron compounds used for fortification. Results indicated that 20-50% more iron was available in the ferripolyphosphate whey protein complex than in sodium ferric-pyrophosphate.

Nonfat dry milk utilization - Wyndmoor, PA. SEA's scientists have utilized CCC stocks of nonfat dry milk (NDM) to manufacture quality cheese and Mozzarella. Procedures and specifications have been developed for ASCS for the manufacture of Mozzarella cheese. The process is now being used by several commercial cheese manufacturers to supply the cheese for school lunch programs in several states. The successful process development will be of benefit in reducing USDA's stocks of surplus NDM.

Eggs:

Cholesterol  $\alpha$ -epoxides in eggs - Albany, CA. A unique method was developed for quantitatively determining cholesterol  $\alpha$ -epoxides at ppm in eggs and egg products. The method requires no chemical modification and is apparently adaptable to other foods. The  $\alpha$  and  $\beta$  isomers of cholesterol epoxides were ineffective in inducing mutations via the Ames test.

Trends in egg production and processing - Athens, GA. A general study of egg production and processing in the Southeast showed that the industry is highly mechanized and that the overall problem is primarily a massive materials handling problem. Trends toward more mechanization will result in more egg damage and loss now between 10 and 15 percent.

Technological Objective 2.:

Relate the composition and properties of animal products and components as influenced by genetics and feeding, production, handling and processing practices to the yield and quality of the finished products.

Research Locations:

5102	Albany, California
7608	Winter Haven, Florida
7902	Athens, Georgia
3102	Peoria, Illinois
1104	Beltsville, Maryland
1402	Wyndmoor, Pennsylvania

Selected Examples of Recent Progress:

Meat:

Rapid protein method improved for meat process control - Wyndmoor, PA. The accuracy and precision characteristics of a 15 min. meat protein determination by dye binding with Acid Orange 12 were established and recommendation made for its adoption as a screening method by AOAC and ASTM organizations. For many uses it offers a rapid alternative to the officially recognized Kjeldahl method which requires 3.5 hours. Rapid protein determination by dye binding complements a referee method for rapid (7-8 min.) fat determination officially recognized by ASTM and AOAC standards organizations and a rapid (4 min.) microwave oven method for moisture which were developed during the course of this project to meet the need for rapid analytical methods.



Protein nutritional quality of cattle organs and blood - Wyndmoor, PA.

New highly useful information on the protein nutritional quality of cattle organs was provided for use in dietary science. Protein nutritional quality as determined individually, by the protein efficiency ratio (PER) of the proteins of cattle organs; liver, heart, kidney, brain, stomach, and intestines, indicated the protein nutritional value of the first three items were about the same as that of casein, a high quality protein, and that the protein quality of stomach and intestines were considerably higher than expected. Data on combinations of blood fractions and whole wheat flour revealed that the proteins of cattle blood, which contain a high quantity of lysine, are mutually supplementary with those of whole wheat flour, which are low in lysine, and produced a PER more than twice that of flour. These findings are significant to a more efficient use of the animal carcass and have strong implications for upgrading protein food sources having low protein quality because of inadequate lysine.

Control of the tenderness and edibility of stored meat - Wyndmoor, PA.

Storage of meat at 10°C for a week or more was shown to result in substantial alterations in the manner in which the myofibrillar proteins are assembled. At 0°C the rate of change was drastically reduced, showing it to be highly temperature dependent; however, some change was detectable after 6 days of storage. This was shown by chromatography of preparations of crude myosin made from meat aging at the two temperatures, followed by electrophoretic analysis of the proteins in the chromatographic fractions. The work gives insight into processes responsible for the tenderness and edibility of meat, and how these might be controlled.

Meat toughness related to postmortem calcium release - Wyndmoor, PA. The intracellular solubilization of calcium before actin and myosin have become permanently linked (rigor mortis) is responsible for fiber shortening resulting in tougher meat. Two intracellular organelles - the sarcoplasmic reticulum and the mitochondria - can sequester calcium. Factors affecting the calcium uptake of these organelles are being studied so that they could be controlled in commercial practice to minimize toughening.

Microchemical methods for the determination of phosphoglycerides (PG) and neutral glycerylethers (GE) in food lipids - Wyndmoor, PA. Methodology was developed for the determination of microgram amounts of PG and GE in lipids (in one-thousandth the amount required by existent technology) using sealed capillary columns of reagent on Celite. Typical reaction times were reduced from hours to minutes. Phospholipids are generally quantified by tedious wet chemical phosphorus assay. An instrumental analysis for phosphorus, based on flame emission spectrometry, is also being developed.

Poultry:

Functional properties of animal protein isolate in mechanically deboned poultry meat - Athens, GA. Protein isolate was found to have a substantial beneficial effect in reducing cooking losses when added to mechanically deboned poultry meat. For mechanically deboned meat without skin, 3% of isolate reduced cooking loss from 20 to 13%. Sodium tripolyphosphate or sodium pyrophosphate at 0.5% level reduced cooking loss to less than 5%.



Sensory evaluation of USDA procured canned boned poultry - Athens, GA.  
Boned poultry procured under USDA specifications revealed major undesirable characteristics (stringiness, non-uniform piece size, metallic taste) in comparison with military specifications and that of the domestic market. Preliminary experiments with retortable pouches hold promise for a gentler process with less deterioration in texture and flavor.

Milk:

Characteristics of submicellar casein - Wyndmoor, PA. A variety of casein monomers at pH 6.6, 0.5 M NaCl, and 37°C associate to maximum values of Stokes radius (8.6 nm) and molecular weight (600,000 daltons). The results were consistent with degrees of association varying from 25-30 monomers for each oligomer. The colloidal complex is assembled from these submicelles.

The major human casein component similar to a bovine casein component - Wyndmoor, PA. Following characterization of a variety of cleavage products of human casein (cyanogen bromide, protease), sequence studies confirmed fragments were identical to bovine  $\beta$ -casein.

Characterization of milk fat globule membrane (MFGM) proteins - Wyndmoor, PA. Fractionation of salt insoluble MFGM proteins in phenol resulted in the isolation of two components. The phenol-soluble component (M.W. 48,700) appeared identical to the previously characterized glycoprotein B. The phenol-insoluble protein remains to be characterized.

Method developed for adsorption of primary alcohols in milk fat - Wyndmoor, PA. Columns of tert-butoxide on Celite preferentially removed primary alcohols in the presence of secondary alcohol. Sterols, including cholesterol, were also adsorbed and may provide a basis for cholesterol removal from animal fats.

Photochemical degradation contributes to off-flavor development in whey - Wyndmoor, PA. Studies have shown that riboflavin in fluid dairy products is photochemically degraded to Lumichrome in the presence of light. Quantitative methodology developed permits estimation of the amount of Lumichrome formed. It is suggested that photochemical reactions lead to off-flavors and nutritional losses in dairy products.

Nuclear magnetic resonance methodology applied to study of protein hydration - Wyndmoor, PA. Proton relaxation studies of  $\beta$ -lactoglobulin, together with longitudinal relaxation times of water protons, were used to determine hydration values. With the establishment of the methodology and mathematical treatments, NMR spectroscopy will be of utility in correlating protein functionality and hydration.

$^{13}\text{C}$  NMR spectroscopy for characterization of butterfat - Wyndmoor, PA.  
 $^{13}\text{C}$  NMR has been effectively used to quantify the amount of butyrate ester in unaltered butter oil by relating the integrated area of the C-2 resonance of butyrate to the C-2 carbon resonance of all other chain length esters.

Mechanism of phosphate incorporation into casein by lactating mammary gland - Wyndmoor, PA. Through phosphorylation studies utilizing the mammary enzyme casein kinase and 30 peptides and proteins, it has been demonstrated that the primary phosphorylation site is a serine residue having either aspartic or glutamic acids, 2 residues away.

Lactose metabolism of lactobacilli and streptococci - Wyndmoor, PA. Studies with 32 strains of thermophilic lactic streptococci showed that one strain grew on lactose only, 19 on lactose and glucose, and 12 on lactose, glucose and galactose. Transport mechanisms for the individual sugars were found to be controlling factors.

Deuterium isotope shifts in carbohydrates used for structure assignments - Wyndmoor, PA. Using a concentric coaxial dual NMR cell, chemical shifts of  $^{13}\text{C}$ -OH and  $^{13}\text{C}$ -OD could be measured simultaneously in two independently equilibrating systems ( $\text{H}_2\text{O}$  and  $\text{D}_2\text{O}$ ). In most cases, direct assignment of the  $^{13}\text{C}$  spectrum could be made without resorting to complex experiments.

Bovine milk component identified as  $\beta_2$ -microglobulin - Wyndmoor, PA. A crystalline protein, lactollin, was isolated from bovine milk in 1963. A comparison of its chemical and physical properties with those of  $\beta_2$ -microglobulin. The  $\beta_2$ -microglobulin is associated with the histocompatibility antigens present on nearly all nucleated cell surfaces. The availability of lactollin ( $\beta_2$ -microglobulin) in a readily crystallizable form will greatly expedite gains in immunological research.

$^{19}\text{F}$  NMR method developed for determining available lysine - Wyndmoor, PA. A new approach to the quantitation of "available lysine" in proteins utilizes  $^{19}\text{F}$  NMR spectroscopy of trifluoroacetylated proteins. In milk and dairy products, preliminary removal of lactose by dialysis is essential to quantitative determinations.

Fate of ingested xanthine oxidase - Wyndmoor, PA. In a cooperative study with the University of Delaware, SEA scientists demonstrated that xanthine oxidase (XO) is not absorbed into the blood stream following ingestion of homogenized milk. No increase in XO activity was observed in the blood of miniature pigs fed a commercial diet supplemented with homogenized bovine milk and XO. These findings tend to disprove a recent theory implicating XO as a causative agent of atherosclerosis in humans.

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This Annual Report was prepared by John Woychik, Eastern Regional Research Center, Philadelphia, PA.

SELECTED PUBLICATIONS

Albany, California

Donovan, J. W. A study of the baking process by differential scanning calorimetry. J. Sci. Fd. Agr. 28: 571-578. 1977.

Donovan, J. W. Differences between ovotransferrin and human serum transferrin in structural and metal-binding cooperativity. IN Iron Metabolism, E. B. Brown, Ed., Grune and Strattaton, N.Y.: 179-186. 1977.

Donovan, J. W. Differential scanning calorimetry: A routine technique for biophysical studies of protein interaction. Federation Proceedings 36: 835. 1977.

Evans, R. W., J. W. Donovan, and J. Williams. Calorimetric studies on the binding of iron and aluminum to the amino- and carboxyl-terminal fragments of hen ovotransferrin. FEBS Letters 83: 19-22. 1977.

Tomimatsu, Y., and J. W. Donovan. Spectrophotometric and differential scanning calorimetric measurements of Zn(II), Al(III) and Ga(III) binding to ovo- and human serum transferrin. IN Iron Metabolism, E. B. Brown, Ed., Grune and Stratton, N.Y.: 221-226. 1977.

Zahnley, J. C. Independence of domains in protease-inhibitor complexes formed by singleheaded and multiheaded inhibitors. Federation Proceedings 36: 765. 1977.

Athens, Georgia

Birth, G. S., C. E. Davis, and W. E. Townsend. The scatter coefficient as a measure of pork quality. J. Animal Sci. Accepted for publication October 1977.

Davis, C. E., W. E. Townsend, and H. C. McCampbell. Early rigor detection in pork carcasses by foreleg position. J. Animal Sci. Accepted for publication September 1977.

Davis, C. E., G. S. Birth, and W. E. Townsend. Analysis of spectral reflectance for measuring pork quality. J. Animal Sci. Accepted for publication October 1977.

Horvat, R. J. Identification of some new minor acids from chicken skin lipids. Poultry Sci. Accepted for publication December 1977.

Townsend, W. E., W. L. Brown, H. C. McCampbell, and C. E. Davis. Comparison of chemical, physical and sensory properties of loins from Yorkshire, crossbred and wild pigs. J. Animal Sci. Accepted for publication October 1977.

Townsend, W. E., A. A. Klose, and B. G. Lyon. Chemical and sensory changes in freeze-dried chicken and pork during high temperature, oxygen-free storage. J. Food Sci. 43: 1-5. 1978.



Whitehead, W. K. Activated sludge treatment of poultry processing wastewater. Poultry Science (In press). 1977.

Peoria, Illinois

Hrubant, G. R., R. A. Rhodes, and J. H. Sloneker. Specific composition of representative feedlot waste, a chemical and microbial profile. ARS-NC 59. 1978.

Nakamura, L. K., and C. D. Crowell. Microbiology of corn fermented with swine waste. IN Developments in Industrial Microbiology, Volume 19. (In press).

Oswald, W. J., C. W. Golueke, and B. A. Weiner. Waste utilization. IN Underexploited Microbial Processes of Potential Economic Value, J. Roger Porter, Ed., National Academy of Sciences, National Research Council, Commission on International Relations, Washington, D.C.: 110-135. 1978.

Weiner, B. A. Characteristics of aerobic, solid substrate fermentation of swine waste-corn mixtures. Eur. J. Appl. Microbiol. 4: 51-57. 1977.

Weiner, B. A. Fermentation of swine waste-corn mixtures for animal feed: Pilot-plant studies. Eur. J. Appl. Microbiol. 4: 59-65. 1977.

Weiner, B. A. A fermentation process for the utilization of swine waste. IN Food, Fertilizer, and Agricultural Residues, Proceedings of the 1977 Cornell Agricultural Waste Management Conference, R. C. Loehr, Ed., Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan: 621-635. 1977.

Wyndmoor, Pennsylvania

Meat

Carroll, R. J., and F. P. Rorer. A rare glimpse into meat structure. Meat Industry: 51. 1977.

Gugger, R. E., and S. M. Mozersky. Micro mixing apparatus and method. U.S. Patent 4,054,270. October 18, 1977.

Jones, S. B. Ultrastructural characteristics of beef muscle. IFT Symposium paper. Food Tech. 31: 82-85. 1977.

Luddy, F. E., J. W. Hampson, S. F. Herb, and H. L. Rothbart. Multistep crystallization and blending process for making physiochemically designed fat compositions from tallow. U.S. Patent 4,049,839. September 20, 1977.

Pettinati, J. D., and C. E. Swift. Collaborative study of precision characteristics of the AOAC method for crude fat in meat and meat products. JAOAC 60: 600-608. 1977.

Pettinati, J. D., and C. E. Swift. Collaborative study of accuracy and precision of the rapid determination of fat in meat and meat products by Foss-Let Method. JAOAC 60: 853-858. 1977.

Pfeffer, P. E., F. E. Luddy, J. Unrah, and J. Shoolery. Analytical  $^{13}\text{C}$  NMR: A rapid, nondestructive method for determining cis, trans composition of catalytically treated lipid mixtures. J. Amer. Oil Chem. Soc. 41: 380-386. 1977.

Rothbart, H. L. Gas chromatographic analysis of food. IN Modern Practice of Gas Chromatography, R. L. Grob, Ed., John Wiley & Sons, Inc.: 451-490. 1977.

Strange, E. D., R. C. Benedict, J. L. Smith, and C. E. Swift. Evaluation of rapid tests for monitoring alterations in meat quality during storage. I. Intact meat. J. Food Protection 40: 843-847. 1977.

Susi, H., and J. S. Ard. A valence force field for nickel porphin and copper porphin. Spectrochim. Acta 33A: 561-567. 1977.

Uchman, W., R. A. Whitmore, S. A. Ackerman, M. L. Happich, and C. E. Swift. Estimation of digestibility of meat products containing extenders. J. Food Sci. 42: 1404-1405. 1977.

#### Dairy

Bingham, E. W., and H. M. Farrell, Jr. Phosphorylation of casein by the lactating mammary gland. A review. J. Dairy Sci. 60:1199-1207. 1977.

Brown, E. M., and H. M. Farrell, Jr. Interaction of  $\beta$ -lactoglobulin and cytochrome C. Arch. Biochem. Biophys. 185: 156-164. 1978.

Cornell, D. G., and N. Filipescu. Photorearrangement of 10-methyloctalone in concentrated acid solution. J. Org. Chem. 42: 3331-3336. 1977.

Dougherty, T. M., J. P. Zikakis, and S. J. Pzucidlo. Serum xanthine oxidase studies on miniature pigs. Nutritional Reports International 16(3): 241-248. 1977.

Dougherty, T. M. Quantitative determination of  $\alpha$ -lactalbumin and  $\beta$ -lactoglobulin in whey protein fractions and of whey protein concentrate in frankfurters using an electroimmunoassay. J. Food Sci. 42: 1611-1614. 1977.

Groves, M. L., and R. Greenberg. Bovine homologue of  $\beta_2$ -microglobulin isolated from milk. Biochem. Biophys. Res. Commun. 77: 320-327. 1977.

Goering, H. K., T. R. Wrenn, L. F. Edmondson, J. R. Weyant, D. L. Wood, and J. Bitman. Feeding polyunsaturated vegetable oils to lactating cows. J. Dairy Sci. 60: 739-748. 1977.

Juszkiewicz, A. and J. Potaczeh. Hydration measurements of polyethylene glycols by an acoustic method. Archiwum Akustyki 12: 160. 1977. Eryhch edition: Archives of Acoustics 2. (In press).

- O'Leary, V. S., C. Sutton, M. Bencivengo, B. Sullivan, and V. H. Holsinger. Influence of lactose hydrolysis and solids concentration of alcohol production by yeast in acid whey ultrafiltrates. *Biotech. & Bioengin.* 19: 1689-1702. 1977.
- O'Leary, V. S., R. Green, B. C. Sullivan, and V. H. Holsinger. Alcohol production by selected yeast strains in lactase-hydrolyzed acid whey. *Biotech. & Bioengin.* 19: 1019-1035. 1977.
- Parks, O. W. Isolation and characterization of nonesterified 3 hydroxy acids in milk. *J. Dairy Sci.* 60: 718-720. 1977.
- Parks, O. W., and C. Allen. Photodegradation of riboflavin to lumichrome in milk exposed to sunlight. *J. Dairy Sci.* 60: 1038-1041. 1977.
- Pfeffer, P. E., J. Sampugna, D. P. Schwartz, and J. N. Shoolery. Analytical <sup>13</sup>C NMR: Detection, quantitation and positional analysis of butyrate in butter oil. *Lipids* 12: 869-871. 1977.
- Purcell, J. M., D. G. Quimby, and J. R. Cavanaugh. A new method for the determination of free amino groups in intact pure proteins: Relationship to available lysine. *JAOC* 59: 1251-1254. 1976.
- Scholnick, F., and W. M. Linfield. Lactose-derived surfactants (III): Fatty esters of oxyalkylated lactitol. *J. Amer. Oil Chem. Soc.* 54: 430-432. 1977.
- Schwartz, D. P. Methods for the isolation and characterization of constituents of natural products. XXI. Use of a Celite-potassium methylate column for rapid preparation of methyl esters from microgram amounts of glycerides. *Microchem. J.* 22: 457-462. 1977.
- Schwartz, D. P., and S. F. Osman. Applications of chromic acid-Celite columns to micro and semimicro preparations of fatty aldehydes. *Anal. Biochem.* 80: 70-75. 1977.
- Weaver, J. C., M. Kroger, and M. P. Thompson. Free amino acid and rheological measurements on hydrolyzed lactose Cheddar cheese during ripening. *J. Food Sci.* 43: 579-583. 1978.
- Woychik, J. H., and V. H. Holsinger. Use of lactase in the manufacture of dairy products. ACS Symposium Series, No. 47, "Enzymes in Food and Beverage Processing," Ory, R. L. and A. J. St. Angelo, Eds. 1977.
- Wrenn, T. R., J. Bitman, J. R. Weyant, D. L. Wood, K. D. Wiggers, and L. F. Edmondson. Milk and tissue lipid composition after feeding cows protected polyunsaturated fat for two years. *J. Dairy Sci.* 60: 521-523. 1977.



ANNUAL REPORT  
FY 1977

National Research Program 20540

TECHNOLOGIES FOR INDUSTRIAL USES--PLANT AND ANIMAL PRODUCTS

This National Research Program involves research leading to technologies for new and improved processes and products to increase the value and industrial utilization of such agricultural materials as starch, vegetable oils, fats and tallow, and hides and leather. Through this research, market opportunities for nonfood agricultural production are expanded and new market opportunities opened. The work involves scientists and engineers at the regional research centers, drawing on a reservoir of scientific knowledge, expertise and facility in working with agricultural materials.

NPS Contact: Andrew M. Cowan

PACS Contact: C. Golumbic

Technological Objective 1.

Generate new knowledge of composition, properties, processes, mechanisms, and reactions related to materials of agricultural origin, components and derivatives as a basis for new technologies.

Research Locations:

Peoria, Illinois  
New Orleans, Louisiana  
Wyndmoor, Pennsylvania

Selected Examples of Recent Progress:

Stable, Reproducible, Fermentative Production of High-Quality Gum. Peoria, Illinois. Understanding the role of content of pyruvic acid ketal in xanthan gum (polysaccharide produced by Xanthomonas campestris NRRL B-1459) has enabled ARS to fulfill all scientific obligations with regard to development of the process. We have now shown that (1) high pyruvate content is related to high viscosity at low gum concentrations (this finding directly relates to energy production through use of gum in oil well drilling fluids and in secondary and tertiary recovery operations), (2) strain variability can now be monitored by determination of pyruvic acid in the product (3) development work on a synthetic medium revealed that minor changes in media and growth conditions influence pyruvate content, and (4) remarkably, as the fermentation proceeds gum of higher pyruvate content is synthesized.

Characterization of Xanthanase and its Hydrolysis Products. Peoria, Illinois. Products of xanthanase action are a high-molecular weight ultraviolet light absorbing (max., 257 nm) polysaccharide and low-molecular weight products. These were separated by precipitation with aqueous alcohol of the degraded biopolymer. Since the macromolecular fragment contains mainly D-glucose and only a trace of D-mannose, it represents the  $\beta$ -(1-4)-linked backbone chain; i.e., trisaccharide sidechains have been removed which contain D-mannose molecular and D-glucuronic acid. The low D-mannose molecular weight fraction has three components: D-mannose, O-acetylated D-mannose, and an acidic sugar.

Improved Strength of Cationic Starch-Elastomer Composites. Peoria, Illinois.

Ionically bonded starch-elastomer composites were made by reaction of basic amine modified starch with carboxylated nitrile elastomer and butadiene-styrene-sulfonic acid polymer. Metal oxide ionic crosslinks supplemented the filler-elastomer bonds in a reprocessable composite that gave tensile strength of 1,500 pounds per square inch and an elongation of 600% at break. This recyclable rubber composite may be useful for replacing some rubber goods now commercially available which are permanently crosslinked and must be discarded after use.

Water-Absorbing Starch Derivatives for Making Internally Plasticized Starch

Film. Peoria, Illinois. Starch, gelatinized in alkaline solutions, was combined with butanediol diglycidyl ether and a variety of aliphatic di- and triols having up to six carbon atoms and hydroxyl groups located at different positions along the carbon chain. Physical properties of films made from these composites suggest that the polyols react in the system to provide strength and plasticity to the films. The most promising polyol, 1,3-propanediol, yielded films with strength properties similar to high-amylose starch. Other promising polyols included 1,2,4-butanetriol and 1,2,6-hexane triol. These studies provide basic information designed to improve the quality of starch films that may have application as biodegradable agricultural mulch and packaging.

Activated Plant Polysaccharides Release Energy. New Orleans, Louisiana.

Illumination of naturally occurring polymers such as cellulose and starch with electromagnetic waves of sufficient energy causes the polysaccharides to become activated so that these large molecules can combine with oxygen. These reactions result in peroxy compounds capable of releasing enough energy to form excited carbonyl compounds that in turn can release energy after relatively long times. Chemiluminescence, or release of energy by polysaccharides over long periods, implies that polysaccharides can play a role in electron transport in plants. In addition, the ability of long chain polysaccharides to stabilize free radicals long enough to activate ground state oxygen can be of importance in the role of oxygen in plant metabolisms.

Technological Objective 2.

Develop new and improved processes and products, applying known principles, which can be utilized to increase economic return to producers, reduce costs to consumers and to satisfy recognized national and consumer needs in health and safety, product quality, environmental quality, conservation of resources, and export and balance of payments.

Research Locations:

Albany, California  
Pasadena, California  
Peoria, Illinois  
Wyndmoor, Pennsylvania



Synthetic Medium for Production of Xanthan Gum. Peoria, Illinois. A synthetic medium was developed for production of high quality (high pyruvate content) xanthan gum in good yields. Minor changes in medium ingredients and growth conditions can result in production of low-pyruvate xanthan. It was further noted that the pyruvate content of the product increased with fermentation time.

Shear Modulus of Water-Swollen Gels. Peoria, Illinois. Shear modulus, a significant measure of internal structure of gels, determined in a cone-and-plate rheometer from viscosity and normal force measurements is not sufficiently precise for comparison of different gels. Sources of variation in this parameter were investigated. In gels of high swelling power, viscosity of their suspensions was low. Lower viscosity fluids tend to develop a secondary, i.e., undesired flow pattern in the cone-and-plate which affects results. The amount of secondary flow depends on instrument geometry, i.e., radius, angle, and speed of the cone, and on sample viscosity and can be minimized by controlling these variables. The normal force measure was improved in precision by use of a guard ring surrounding the plate. The ring affected both viscosity and normal force measurements, and reduced secondary flow. These improved methods allow us to better characterize highly swelling gels.

Soybean oil-derived Solventless Coatings to Reduce Use of Petroleum Solvents and Vehicles in Industrial Coatings. Peoria, Illinois. Solventless coatings were prepared from different oxonolysis and oxo derivatives including the dimethyl acetals and enol ethers of methyl azelaaldehyde and methyl formylstearate, and methyl 9,9(10,10)-bis(hydroxymethyl)octadecanoate. For cross-linking, hydroxyl moieties were introduced by alkaline aminolysis with ethanolamine and diethanolamine. Films were prepared from blends of these hydroxy esters and commercial resins. Blends with hexamethoxy-methylmelamine gave the hardest films but the poorest impact and elongation resistances. Blends with methylated urea-formaldehyde were softer but gave better impact and elongation. This objective is now terminated.

New Chemical Modification of Saturated Fatty Acids. Wyndmoor, Pennsylvania. In a program designed to control the introduction of substituents into long chain fatty acids at specific positions, a halogenation reaction has been discovered that leads to the direct preparation of delta and gamma lactones from saturated fatty acids. The reaction is chemically unique for the discovery that the halogen in chlorinated fatty acids is labile and can be isomerized by strong protonic acids. The reaction provides a basis for studying the introduction of other functionalities.

Low Energy Oxidation of Fatty Acids. Wyndmoor, Pennsylvania. A new low-energy method has been developed to oxidize unsaturated fatty acid soaps and thereby produce shorter chain mono- and dicarboxylic acids. For instance, potassium oleate can be cleaved to produce pelargonic acid and azelaic acid. Both of these acids, which are in demand for use in the lubricant and plasticizer fields, are presently produced industrially by a high energy, capital intensive ozonolysis reaction. In the new method, catalytic amounts of ruthenium dioxide, used in conjunction with the common cooxidant sodium hypochlorite, accomplish the quantitative conversion to products at ambient temperatures and pressures in commonly available processing equipment.



Selected Examples of Recent Progress:

Correlation Effect of Vertical Fiber Defect with Reproductive Performance. Wyndmoor, Pennsylvania. A previously reported hide biopsy study of 60 twin heifers revealed a high incidence of the vertical fiber defect in the 30 Herefords and provided further convincing evidence that the defect is genetically controlled. Partial sampling of the 148 crossbred progeny of these cows provided not only information on transmission of the defect, but later analysis of the calving records indicated a new, more serious correlation with reproductive performance. The Hereford cows with extreme degree of hide defect has produced only a 53 percent live calf crop whereas the normal Herefords had achieved 90 percent. The study was obviously too small for statistical confidence. However, if the effect is confirmed, elimination of the defect by selective breeding would be highly beneficial to the beef cattle industry.

Labor Reduction in Automated Hide Splitting. Wyndmoor, Pennsylvania. The change from horizontal to vertical splitting eliminated the second operator normally required on the discharge side of a conventional machine.

Shoes from PolyRetan Leathers. Wyndmoor, Pennsylvania. In a 6 month wear test conducted in India under PL 480, shoes made from the PolyRetan leathers supplied by USDA were superior to those made from a synthetic, poromeric material in foot comfort and to shoes made from commercial leather in appearance, crack resistance and shape retention. The results suggest that the shoes made from the PolyRetan leathers are better able to compete with shoes made from poromerics than are shoes made from commercial leather.

Modified Soap Detergents. Wyndmoor, Pennsylvania. Research and development of a soap-based phosphate-free detergent has resulted in the adoption of the ERRC technology by several firms in Japan. The outstanding features of this type of detergent are a) absence of water pollution because of the ready biodegradability of the detergent and elimination of phosphate builder, b) use of a replenishable agricultural byproduct tallow as a raw material in place of petroleum and c) high detergency performance. The research has received widespread recognition both in the U.S. and abroad and resulted in an invitation to present the research at a World Conference on Soaps and Detergents at Montreux, Switzerland.

Pesticide Efficacy Increased. Peoria, Illinois. A rather simple and economical process has been developed whereby a wide range of pesticides can be encapsulated within a matrix formed by a starch derivative. The starch matrix is biodegradable and the rate of release of the pesticide can be controlled by varying the derivatizing process or by changing the encapsulation step. Preliminary tests with encapsulated herbicides show weed control for the entire growing season with an evident reduction in energy requirements for multiple herbicide applications or tillage. The pesticide remains where targeted and reduces environmental impact, and the safety to farmers of handling toxic pesticides is greatly increased. Overall, efficiency of encapsulating agents for controlling weeds has been demonstrated to be improved several-fold when compared to standard formulations. This technology shows promise for reducing the current 7.5 billion dollar annual loss in crop production caused by weeds.

Starch-Based Plastics. Peoria, Illinois. Various degrees of water solubility and biodegradability were achieved by incorporating starch into plastics. These studies led to the multimillion pound production of water-soluble laundry bags, and pesticide containers which protect workers from possible contaminated hospital linen and hazardous chemicals. Other starch-based films and rigid plastics show promise for application as biodegradable mulch for vegetable crops to retain moisture, prevent loss of fertilizer and keep down weed growth. Extension of these concepts is expected to yield a variety of products for improving agricultural technology such as biodegradable planters and containers.

Product Developed to Remove Toxic Metals from Water. Peoria, Illinois. A modified starch product efficiently removes heavy metal ions from municipal and industrial wastewaters to below discharge limits set by the Environmental Protection Agency. Developed under partial support from EPA the product is being produced by two companies and several more are using it for abating pollution caused by heavy metals. Removal of the metals allows for reuse of the water thus conserving this valuable resource.

Super Slurper for Improved Water Handling. Peoria, Illinois. This starch-derived product developed at the Northern Regional Research Center has unique properties for absorbing and retaining more than 1000 times its weight in distilled water or about 500 times its weight in tap water. Super Slurper is now being used in commercial products for the absorption of body fluids such as urine, blood, and perspiration, and it appears to have promise for use in animal litter and bedding; solidification of wastewater and sewage sludge for easier handling; drying wet basement and athletic fields; thickening of cosmetics, agricultural sprays, and fire-fighting fluids; and removing water from solvents and oil. Independent estimates have placed the total market potential for Super Slurper-like products at about 1 billion pounds annually. Four commercial firms are either already manufacturing products based on this invention or have plants to do so under construction and 30 other firms have been issued licenses to use the product. Several of these firms are newly formed solely to practice this technology.

New Wood Preservative. Albany, California. Working cooperatively with scientists at the Naval Research Laboratory, Washington, D. C., SEA scientists have shown that a simple phenol (2-benzyl-4,6-di.tert.butyl phenol), which could be synthesized easily, preserves woods from attack by marine borers and other organisms in tropical waters. The compounds appear to be more efficient than pentachlorophenol or creosote as a protective agent against marine borers.

Repellents for the Confused Flour Beetle. Albany, California. SEA scientists in Georgia and California have found that simple benzyl-mono alkyl phenols are highly effective repellents for the confused flour beetle, the chief pest of stored cereal grains. These repellents are long lasting and more effective than the standard pyrethrum repellent. They could prove to be useful for the preservation of cereal grains where direct contact with insecticides is undesirable.

Hydrocarbons from Plants. Pasadena, California. SEA scientists have chemically treated guayule, a desert shrub native to Texas and Mexico, causing the plant to produce over 3 times the rubber it normally yields. Such increase might lead to a commercially feasible, domestic natural source of rubber to replace the 719,000 tons imported yearly at a cost of over \$500 million.

Identification of U.S. Plant Species With Useful Amounts of Rubber and/or Other Hydrocarbons. Peoria, Illinois. Criteria were established for the preliminary evaluation (screening) of plant species as potential multi-use hydrocarbon producing crops. A total of 206 plant species representing 57 families and 141 genera were evaluated, of which 30 species offer promise. Several of these species are mainly of interest for oil or polyphenol production, but the six best rated species all produce natural rubber (NR). These six species were Asclepias subлата (desert milkweed), Asclepias syriaca (common milkweed), Cacalia atriplicifolia (pale Indian plant), Chrysothamnus nauseosus (rabbit brush), Parthenium argentatum (Guayule), and Solidago leavenworthii (Edison's goldenrod). Molecular weights ( $M_w$ ) of NR from 33 temperate zone plants and Guayule were measured by gel-permeation chromatography. Guayule and four other species (Pycnanthemum incanum, Lamiae-strum galeobdolon, Monarda fistulosa, Vernonia fasciculata) produced NR with  $M_w$  values above  $4 \times 10^5$ , comparable to milled conventional Hevea NR. The other species produced lower  $M_w$  rubbers suitable for paste or liquid rubber processing or desirable as hydrocarbon feedstocks.



PUBLICATIONS

Albany, California

Jurd, L. 1977. Quinones and quinone methides. 1. Cyclization and dimerization of crystalline ortho-quinone methides from phenol oxidation reactions. Tetrahedron. 33:163-168.

Jurd, L. and Manners, G. D. 1977. Isoflavene, isoflavan and flavenoid constituents of Gliricidia Sepium. J. Agr. Food Chem. 25:723-726.

Manners, G. D. and Jurd, L. 1977. The hydroquinone terpenoids of Cordia alliodora. J. Chem. Soc. Perkin 1:405-409.

Manners, G. D. and Jurd, L. 1977. New natural products from marine borer resistant woods. J. Agr. Food Chem. 25:726-729.

Molyneux, R. J. and Wong, R. Y. 1977. Formation of enamine Schiff bases by ring clearance of pyridine. Tetrahedron. 33:1931.

Wong, R. Y., Manners, G.D., and Palmer, K. J. 1977. The crystal structure and absolute configuration of (+) - Iso olivil,  $C_{20}H_{24}O_7C_3H_6O.H_{20}$ . Acta Cryst. B33:970-974.

Pasadena, California

Yokoyama, H., E. P. Hayman, W. J. Hsu and S. M. Poling. Chemical bioinduction of rubber in guayule. Science, 197:1076-1077, 1977.

Peoria, Illinois

Bagley, E.B., G. F. Fanta, R. C. Burr, W. M. Doane, and C. R. Russell. Graft Copolymers of Polysaccharides with Thermoplastic Polymers. A New Type of Filled Plastic. Poly. Eng. Sci. 17 (1977):311.

Bell, E. W. and L. E. Gast. Alkyd Resins Modified with Tetrafluoroethylene Adduct of Conjugated Linseed Fatty Acids. J. Paint Technol. 50 (1978):81-87.

Bell, E. W., L. E. Gast, and F. L. Thomas. Sperm Oil Replacements: Synthetic Wax Esters from Selectively Hydrogenated Soybean and Linseed Oils. J. Am. Oil Chem. Soc. 54 (1977):259-263.

Buchanan, R. A., I. M. Cull, F. H. Otey, and C. R. Russell. Hydrocarbon and Rubber-Producing Crops: Evaluation of 100 U.S. Plant Species. Presented at 11th Great Lakes Regional Meeting, American Chemical Society, Stevens Point, Wisconsin, June 6-8, 1977.

Cadmus, M. C., C. A. Knutson, A. A. Lagoda, J. E. Pittsley, and K. A. Burton. Synthetic Media for Production of Quality Xanthan Gum in 20-Liter Fermentors. Symposium on Biochemical Engineering and Microbial Processes: Microbial Products. Abstracts of Papers 2nd Joint Conference Chemical Institute of Canada, American Chemical Society, Montreal. May 29-June 2, 1977. CSCE 29.

Cadmus, M. C., C. A. Knutson, A. A. Lagoda, J. E. Pittsley, and K. A. Burton. Synthetic Media for Production of Quality Xanthan Gum in 20-Liter Fermentors. *Biotechnol. Bioeng.* 20 (1978), in press.

Carr, M. E., G. E. Hamerstrand, B. T. Hofreiter, and C. R. Russell. A Polysalt Complex for Wet-End Addition. *Tappi* 60 (1977):148-149.

Carr, M. E., B. T. Hofreiter, M. I. Schulte, and C. R. Russell. A Starch Polyampholyte for Paper. *Tappi* 60 (1977):66-88.

Carr, M. E., B. T. Hofreiter, M. I. Schulte, and C. R. Russell. Starch Polyampholytes with Amine and Xanthate Substituents. Accepted for publication in *J. Appl. Polym. Sci.*, December 15, 1976.

Cheng, W. C. and M. E. Carr. O-Carboxymethylstarch Amine Polyampholytes as Papermaking Additives. Accepted for publication in *Staerke*, November 30, 1977.

Fanta, G. F., R. C. Burr, W. M. Doane, and C. R. Russell. Graft Polymerization of Vinyl Acetate onto Starch. Saponification to Starch-g-Poly(Vinyl Alcohol). *Appl. Polym. Sci.*, in press.

Fanta, G. F. and W. M. Doane. Highly Absorbent Polymeric Compositions Derived from Flour. U. S. Patent 4,045,387, (August 30, 1977).

Fanta, G. F., F. L. Baker, R. C. Burr, W. M. Doane, and C. R. Russell. Scanning Electron Microscopy of Saponified Starch-g-Polyacrylonitrile. *Staerke*, in press.

Frankel, E. N. and E. H. Pryde. Catalytic Hydroformylation and Hydrocarboxylation of Unsaturated Fatty Compounds. *J. Am. Oil Chem. Soc.* 54 (1977)873A-881A.

Frankel, E. N. C-19 Dibasic Acid, Process and End Uses. Paper presented at American Oil Chemists' Society, New York, New York, May 9-12, 1977.

Gast, L. E., W. J. Schneider, and F. L. Baker. Polyesteramides from Linseed and Soybean Oils for Protective Coatings. Scanning Electron Microscopic and Durability Studies. *J. Coatings Technol.* 49 (1977):57-62.

Gugliemelli, L. A., C. L. Swanson, W. M. Doane, and C. R. Russell. Preparation of Starch Poly(Styrene-Co-Acrylonitrile) Graft Polymer by Cerium (IV) Initiation. *J. Polym. Sci., Polym. Lett. Ed.*, in press.

Gugliemelli, L. A., W. M. Doane and C. R. Russell. Preparation of Soapless Latexes by Sonification of Starch-Based Poly(Isoprene-Co-Acrylonitrile) Graft Reaction Mixtures. *J. Appl. Polym. Sci.*, in press.

Hamerstrand, G. E., B. S. Phillips, J. C. Rankin, H. D. Heath, M. I. Schule, and B. T. Hofreiter. Environmental Impact of Residual Surface Sizes in Secondary-Fiber Furnishes. Tappi 61 (1978):81-84.

Hamerstrand, G. E., M. E. Carr, B. T. Hofreiter, and C. R. Russell. Starch Xanthate Interpolymer in Groundwood Printing Paper. Svensk Papperstidning 80 (1977):508-509.

Hofreiter, B. T. Amylose Graft Polymers made by <sup>60</sup>Co Gamma-Irradiation. J. Appl. Polym. Sci. 21 (1977):761-772.

Jeanes, A. Dextrans and Pullulans: Industrially Significant Alpha-D-Glucans. ACS Symp. Ser. No. 45 (1977):284-298.

Kidby, D., P. Sandford, A. Herman, and M. Cadmus. Maintenance Procedures for the Curtailment of Genetic Instability: Xanthomonas campestris NRRL B-1459. Appl. Environ. Microbiol. 33 (1977):840-945.

Kohlhase, W. L., E. N. Frankel, and E. H. Pryde. Polyamides from Carboxystearic Acid. J. Am. Oil Chem. Soc. 54 (1977):506-510.

Kohlhase, W. L., W. E. Neff, and E. H. Pryde. Isolation of the 9- and 10-Isomers of Carboxystearic Acid and Their Polyamidation with Hexamethylenediamine. J. Am. Oil Chem. Soc. 54 (1977):521-524.

Maher, G. G. Crosslinking of Starch Xanthate. IV. Epoxy Resin and Diepoxide Thickeners for Xanthate and Starch. Staerke 29 (1977):335-339.

Miller, W. R. and E. H. Pryde. Geminal Hydroxymethyl Compounds from 9(10)-Formylstearic Acid. J. Am. Oil Chem. Soc. 54 (1977):882A-885A.

Otey, F. H., R. P. Westhoff, and C. R. Russell. Biodegradable Films from Starch and Ethylene-Acrylic Acid Copolymer. Ind. Eng. Chem., Prod. Res. Deve. 16 (1977):305-308.

Pittsley, J. E., P. A. Sandford, C. A. Knutson, and A. Jeanes. Rheological Properties of Polysaccharide Mixtures. I. Synergistic Interactions of Xanthan Gum and Various Other Microbial Polysaccharides with Galactomannans. Great Lakes Regional ACS Meeting, Stevens Point, Wisconsin, June 6-8, 1977.

Pryde, E. H. Nonfood Uses for Commercial Vegetable Oil Crops. In "Crops Resources" (D. S. Seigler, ed.), Academic Press, Inc., 1977, pp. 25-45.

Pryde, E. H. Unsaturated Polyamides, J. Macromol. Sci. - Reviews in Macromol. Chem., in press.

Pryde, E. H. Carboxylic Acids - Economic Aspects. Chapter in Encycl. Chem. Technol., in press.

Rakoff, H., F. L. Thomas, and L. E. Gast. Inhibition of Yellowing in Linseed Oil Paints. J. Coatings Technol. 49 (1977):48-50.



Rakoff, Henry, W. F. Kwolek, and L. E. Gast. Drier Composition and the Yellowing of Linseed Oil Films. *J. Coatings Technol.* 50 (1978):51-55.

Rankin, J. C. and B. S. Phillips. Low pH Preparation of Cationic Starches and Flours. Patent Application, Serial No. 811,399 (June 29, 1977).

Sanford, P. A., P. R. Watson, K. A. Burton, and M. C. Cadmus. Cationic Galactosamine Exopolysaccharide from Various Aspergillus Species. Abstracts 174th American Chemical Society National Meeting, Chicago, Illinois, August 28-September 2, 1977. CARB 27.

Sandford, P. A., J. E. Pittsley, and C. A. Knutson. Rheological Properties of Polysaccharide Mixtures. II. Synergistic Interaction of Xanthan Gum with Various Acidic and Neutral Polysaccharides. Abstracts 174th National Meeting ACS, Chicago, Illinois, August 28-September 2, 1977. CARB 28.

Sandford, P. A., P. R. Watson and C. A. Knutson. Separation of Xanthan Gums of Differing Pyruvate Content of Fractional Precipitation with Alcohol. Abstracts 174th National Meeting ACS, Chicago, Illinois, August 28-September 2, 1977. CARB 29.

Sandford, P. A., J. E. Pittsley, C. A. Knutson, P. R. Watson, M. C. Cadmus and A. Jeanes. Variation in Xanthomonas campestris NRRL B-1459: Characterization of Xanthan Products of Differing Pyruvic Acid Content. ACS Symp. Ser. No. 45 (1977):192-210.

Sandford, P. A., P. R. Watson, and C. A. Knutson. Separation of Xanthan Gum of Differing Pyruvate Content by Fractional Alcohol Precipitation. *Carbohydr. Res.* 62 (1978), in press.

Sandford, P. A., J. E. Pittsley, A. Jeanes, and C. A. Knutson. Synergistic Interaction of Various Microbial Polysaccharides with Galactomannans. *Carbohydr. Res.* Accepted for publication.

Seymour, F. R., M. E. Slodki, R. D. Plattner, and A. Jeanes. Six Unusual Dextrans: Methylation Structural Analysis by Combined G.L.C.-M.S. of Per-O-Acetyl-Aldononitriles. *Carbohydr. Res.* 53 (1977): 153-166.

Swanson, C. L., R. A. Buchanan, and F. H. Otey. Molecular Weights of Natural Rubbers from Selected Temperate Zone Plants. Presented at 1977 International Symposium on Liquid Chromatography Analysis of Polymers and Related Materials Chicago, Illinois, November 7-10, 1977.

Taylor, N. W. and E. B. Bagley. Rheology of A Cellulose Graft Copolymer. Comparison with Other Closely Packed Gel Thickeners. *J. Appl. Polym. Sci.* 21 (1977):1607-1613.

Taylor, N. W., G. F. Fanta, W. M. Doane, and C. R. Russell. Swelling and Rheology of Saponified Starch-g-Polyacrylonitrile Copolymers. Effect of Starch Granule Pretreatment and Grafted Chain Length. *J. Appl. Polym. Sci.*, in press.

Weaver, M. O., R. R. Montgomery, L. D. Miller, V. E. Sohns, G. F. Fanta, and W. M. Doane. A Practical Process for the Preparation of Super Slurper, a Starch-based Polymer with a Large Capacity to Absorb Water. Staerke, in press.

Wing, R. E., W. E. Rayford, and W. M. Doane. Ferrous Sulfate Treatment for Rinse Waters from the Electroless Plating of Copper. Plat. Surf. Finish 64 (10) (1977):39-43.

Wing, R. E., W. E. Rayford, and W. M. Doane. Treatment of Electroless Nickel Plating Rinse Waters. Met. Finish., in press.

Wing, R. E. and W. E. Rayford. Use of Spent Pickle Liquor in the Treatment of Electroless Copper- and Copper Ammonia Etchant-Rinse Waters. Met. Finish., in press.

Wing, R. E., B. K. Jasberg, and L. L. Navickis. Insoluble Starch Xanthate: Preparation, Stabilization, Scaleup, and Use. Staerke, in press.

Wing, R. E., W. E. Rayford, and W. M. Doane. Treatment Process for Copper Pyrophosphate Electroplating Rinse Waters. Met. Finish 75(5) (1977):101-104.

Wing, R. E., W. E. Rayford, and W. M. Doane. Treatment Process for Some Rinse Waters from the Electroless Plating of Copper. Plat. Surf. Finish 64(6) (1977):57-62.

Wing, Robert E., Leo L. Navickis, Brian K. Jasberg, and Warren E. Rayford. Removal of Heavy Metals from Industrial Wastewaters using Insoluble Starch Xanthate. EPA Interagency Agreement Final Report. Accepted April 1977. (Technical Research Report).

Wing, R. E. and W. E. Rayford. Heavy Metal Removal Processes for Plating Rinse Waters. Proceedings of the 32nd Industrial Waste Conference, Purdue University, Engineering Extension Series. 1977.

#### New Orleans, Louisiana

Perrier, D. M., R. R. Benerito and R. H. Steele, "Preparation of Stable Strong Base Cellulose Anion Exchangers with Redox Potentials." U.S. Patent 4,032,293, June 28, 1977.

#### Wyndmoor, Pennsylvania

Bailey, D. G. and A. A. Gricoski. The Effect of Preservation Treatments on the Extraction of Protein from Fresh Cattlehides. 173rd National Meeting of the American Chemical Society, New Orleans, LA, March 21-27, 1977.

Bailey, D. G. and W. J. Hopkins. Cattlehide Preservation with Sodium Sulfite and Acetic Acid. J. Amer. Leather Chemists' Assoc. 72 (1977):334-339.

Bilyk, A. and E. J. Saggese. Urethane Polyols from Epoxidized Tallow, Sorbitol and Propylene Oxide, Presented at American Chemical Society, 11th Middle Atlantic Regional Meeting, Newark, Delaware, April 20-23, 1977.

Bistline, R. J., Jr., W. R. Noble, F.D. Smith and W. M. Linfield. Cosulfation of Fatty Acid Alkanolamides and Lower Molecular Weight Alcohols. J. Am. Oil Chemists' Soc. 54 (1977):371-374.

Bitcover, E. H., W. F. Happick, J. E. Cooper, E. M. Filachione, and J. W. Harlan. Effect of Effluent Composition Variables on Flocculation of Suspended Solids in Lime Sulfide Unhairing Effluents. J. Amer. Leather Chemists' Assoc. 72 (1977): 426-443.

Bitcover, E. H., J. E. Cooper, W. F. Happick, and E. M. Filachione. Removal of Suspended Solids from Lime-Sulfide Unhairing Effluents. J. Amer. Leather Chemists' Assoc. 72 (1977):172-183.

Colfer, P. A. and T. A. Foglia. Homogeneous Platinum II-Catalyzed Hydrogen-Deuterium Exchange in Nonanoic Acid. American Chemical Society, 11th Middle Atlantic Regional Meeting, Newark, Delaware, April 20-23, 1977.

Everett, A. L., M. V. Hannigan, and D. G. Bailey. New Genetic Information on Vertical Fiber Defect and the Role of Defect in Causing Puller Damage to Cattlehides. 73rd ALCA Meeting, Buck Hill Falls, PA, June 19-23, 1977.

Everett, A. L., R. W. Miller, W. J. Gladney, and M. V. Hannigan. Effects of Some Important Ectoparasites on the Grain Quality of Cattlehide Leather. J. Amer. Leather Chemists' Assoc. 72 (1977)6-24.

Feairheller, S. H., M. M. Taylor, and D. G. Bailey. <sup>35</sup>S-Sulfide Incorporation during Alkaline Treatment of Keratin and its Relation to Lanthionine Formation. Advances in Expt'l. Biol. 86B (1977):177-186.

Foglia, T. A. Analysis of a-Branched Chain Fatty Acids by Gas Chromatography and Mass Spectrometry. Am. Oil Chemists' Society Meeting, New York, N.Y. May 8-12, 1977.

Foglia, T. A., P. A. Barr, A. J. Malloy and M. J. Costanzo. Oxidation of Unsaturated Fatty Acids with Ruthenium and Osmium Tetroxide. J. Am. Oil Chemists' Soc., 54 (1977):870A-872A.

Foglia, T. A., P. A. Barr and A. J. Malloy. Oxidation of Alkenes with Use of Phase Transfer Catalysis. J. Am. Oil Chemists' Soc. 54 (1977):858A-861A.

Gruber, H. A., E. H. Harris, and S. H. Feairheller. Characterization of the Chromium-III Crosslinked Collagen-Poly (Butyl Acrylate) Graft Copolymer. J. Appl. Polymer Science 21 (1977):3465-3471.



- Happick, W. F., J. E. Cooper, E. H. Bitcover, M. M. Taylor, J. W. Harlan, and E. M. Filachione. Effect of Acclimation to Lime-Sulfide Effluent from Unhairing Cattlehides on the Composition of Activated Sludge. J. Amer. Leather Chemists' Assoc. 72 (1977):120-135.
- Harlan, J. W. and S. H. Fearheller. Chemistry of the Crosslinking of Collagen during Tanning. Advances in Experimental Biol. 86A (1977):425-440.
- Harris, E. H. and S. H. Fearheller. Crosslinking Systems in the Graft Polymerization of Chromium-Tanned Collagen. Polym. Eng. Sci. 17 (1977):287-293. (also in AIChE Symposium Series, Vol. 73, No. 170, pp. 131-132 (1977)).
- Kaminski, J. M. and W. M. Linfield. Soap-based Detergent Formulations: XXIII. Synthesis of p-Sulfobenzyl Ammonium Inner Salts and Structural Correlation with Analogous Amphoterics. J. Am. Oil Chemists' Soc. 54 (1977):516-520.
- Konen, D. A., R. J. Maxwell and L. S. Silbert. Factors Influencing Specific Site Reactions of Fatty Acid Derivatives. Presented at American Chemical Society, 11th Middle Atlantic Regional Meeting, Univ. of Delaware, Newark, Del. April 20-23, 1977.
- Linfield, W. M. Soap and Lime Soap Dispersants. J. Am. Oil Chemists' Soc. 55 (1978):87-92.
- Maurer, E. M., J. K. Weil and W. M. Linfield. The Biodegradation of Esters of  $\alpha$ -Sulfo Fatty Acids. J. Am. Oil Chemists' Soc. 54(1977):582-584.
- Maxwell, R. J., L. S. Silbert, and J. R. Russell. Thiocyanations 2. Solvent Effects on the Product Distribution of the Thiocyanogen-Olefin Reaction. J. Org. Chem. 42 (1977):1510-1515.
- Maxwell, R. J. and L. S. Silbert. Thiocyanations 3. Preparation of 2-Imino-1,3-dithiolane Salts by Cyclization of vic=Dithiocyanates. J. Org. Chem. 42 (1977):1515-1517.
- Maxwell, R. F., G. G. Moore and L. S. Silbert. Thiocyanations 4. Cyclization of 1-Isothiocyanto-2-thiocyanates. A Stereospecific Route to the Preparation of 4,5-Thiazolidine-2-Thiones. J. Org. Chem. 42 (1977):1517-1520.
- Maxwell, R. J., P. E. Pfeffer and L. S. Silbert. Thiocyanations 5. Nuclear Magnetic Resonance Analysis of the Stereochemistry of  $\alpha,\beta$ -Dithiocyanates and  $\alpha$ -Isothiocyanto- $\beta$ -Thiocyanates. J. Org. Chem. 42 (1977):1520-1523.
- Micich, T. J., W. M. Linfield, and J. K. Weil. Soap-Based Detergent Formulations: XIX. Amphoteric Alkylsuccinamide Derivatives as Lime Soap Dispersants. J. Am. Oil Chemists' Soc. 54 (1977):91-94.
- Micich, T. J. and W. M. Linfield. Soap-based Detergent Formulations: XXII. Sulfobetaine Derivatives of N-Alkyl-glutamides and Adipamides. J. Am. Oil Chemists' Soc. 54(1977):264-267,

- Moyer, B. G., P. E. Pfeffer, J. L. Moniot, M. Shamma, and D. L. Gunstine. Corollin, Coronillin and Coronarion: Three New 3-Nitropropanoyl-D-Glucopyranoses From *Coronilla Varia*. *Phytochemistry* 16(1977):375-377.
- Parris, N., C. J. Pierce and W. M. Linfield. Soap-Based Detergent Formulations: XXIV. Sulfobetaine Derivatives of Fatty Amides. *J. Am. Oil Chemists' Soc* 54: (1977):294-267.
- Parris, N., W. M. Linfield and R. A. Barford. Analysis of Sulfobetaine Amphoteric Surfactants by Reverse Phase HPLC. *Anal. Chem.* 49 (1977):2228-2231.
- Pfeffer, P. E., G. G. Moore, P. D. Hoagland, and E. S. Rothman. Stereoselective Synthesis and Properties of 1-O-Acyl-D-Glucopyranoses. Book Chapter in "Synthetic Methods for Carbohydrates", ed. H. S. El Khadem, Chapter 9, pp. 155-178, 1976, ACS Symposium Series, No. 39, American Chemical Society, Washington, D. C.
- Pfeffer, P. E., E. S. Rothman, and G. G. Moore. Stereochemical Control in the Acylation of 2,3,4,6-Tetra-O-Benzyl-D-glucopyranose. A Route to 1-O-Acyl- $\alpha$ - and  $\beta$ -glucopyranoses. *J. Orga. Chem.* 41 (1976):2925-2927.
- Pfeffer, P. E., F. E. Luddy and J. Unruh. Analytical <sup>13</sup>C NMR. A Rapid Non-destructive Method for Determining the cis, trans composition of Catalytically Treated Unsaturated Lipid Mixtures. *J. Am. Oil Chemists' Soc* 54: (1977):380-386.
- Serota, S. and L. S. Silbert. What's so Sacred About 14.7 psi? *Chemtech* 7: (1977):248-254.
- Serota, S. H., L. S. Silbert, and G. Maerker. Novel Acylation of Fibrous Cellulosic Materials. American Chemical Society Meeting, New Orleans, LA. March 20-25, 1977.
- Sinnamon, H. I. and Komanowsky, M. Improved Treatment of Lime-Sulfide Unhairing Waste. Patent allowed 1/11/78
- Taylor, M. M., E. H. Harris, and S. H. Fearheller. Graft Polymerization. IV. Further Studies of the Initiation Step in the Graft Polymerization of Vinyl Monomers onto Chrome-Tanned Collagen. *J. Americ. Leather Chemists' Assoc.* 72(1977):294.
- Weil, J. K., C. A. Schollenberger, and W. M. Linfield. The Mutual Solubilization of Soap and Lime Soap Dispersing Agents. *J. Am. Oil Chemists' Soc.* 54: (1977):1-3.
- Weil, J. K., C. J. Pierce and W. M. Linfield. Soap-Based Detergent Formulations XX. The Physical and Chemical Nature of Lime Soap Dispersions. *J. Am. Oil Chemists' Soc.* 53(1977):757-761.
- Weil, J. K. and W. M. Linfield. Surface-Active Properties of Combinations of Soap and Lime Soap Dispersing Agents. *J. Am. Oil Chemists' Soc.* 54(1977):339.
- Weil, J. K. Effect of Lime Soap Dispersing Agents on the Solution Properties of Soap. Am. Oil Chemists' Society Annual Meeting, New York, NY, May 8-12, 1977.

ANNUAL REPORT  
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National Research Program 20550

TECHNOLOGIES FOR FIBER USES

This NRP is concerned with processing of agricultural based fibers, from the time they leave the farm or ranch until they are manufactured into consumer products. Cotton and wool are the principal commodities; but mohair from the fleece of the angora goat and kenaf, flax, and other agricultural fiber crops used in making textiles and paper are also included. The principal objective of the program is to provide the technologies needed to permit these agricultural fibers as renewable resources to compete effectively with petroleum based products for consumer acceptance in the marketplace to the benefit of the farm community, consumers, and the economy. This will be accomplished through basic and applied research aimed at improving product quality, reducing costs, and imparting performance properties desired by consumers. It involves development, and where necessary, demonstration of new and improved equipment, processes and products. The safety of workers and of ultimate consumer products are important considerations, as are conservation of energy, and reduction in environmental pollution from processing.

NPS Contact: N. F. Getchell

PACS Contact: C. Golumbic

Technological Objective 1:

Improve instruments, methods, and technology to identify, evaluate, and maintain fiber quality as it relates to actual use value.

Research Locations:

Clemson, South Carolina

Selected Examples of Recent Progress:

Improved cotton classification instrument system - Clemson, SC. SEA scientists have improved instrument reliability and data processing procedures for the cotton classification system. Improvements have made the system acceptable for nationwide use in AMS classing offices. Instrument classification will provide the cotton buyer with greatly expanded cotton quality information while providing automatic data processing in a more efficient cotton marketing system.

Machine design influences OES rotor deposits - Clemson, SC. Microdust in open-end spinning rotors increases production costs and adversely affects spinning performance and quality of open-end spun cotton yarns. SEA research has shown that dust accumulation rates are influenced more by machine design than by the non-lint content of the cotton being processed. The variation in performance between machines is due to differences in trash removal devices, rotor geometry, and rotor surface coatings.



Characterizing cotton sugars - Clemson, SC. Stickiness caused by high sugar content of certain cottons causes problems in textile processing. SEA scientists have developed improved test methods that characterize cottons for sugar and other water-soluble constituents. The new methodology will help to define cotton spinning quality.

Automated spinning strength tester - Clemson, SC. SEA scientists have developed a new spinning strength tester which automatically breaks and splices a normally-spinning yarn end and transmits the resulting information to a computer for analysis.

## Technological Objective 2:

Develop improved methods for ginning & cleaning agricultural fibers and for preparing them for conversion into yarns, webs & fabrics.

## Research Locations:

Peoria, Illinois  
New Orleans, Louisiana  
Stoneville, Mississippi  
Mesilla Park, New Mexico  
Clemson, South Carolina  
Lubbock, Texas

## Selected Examples of Recent Progress:

Fuel conservation - Lubbock, TX. SEA research has shown that inexpensive insulation applied to drying systems at cotton gins can reduce fuel consumption by as much as 25 percent, a potential savings of approximately 380 million cubic feet per year in Texas alone.

High cotton roller ginning rate obtained - Mesilla Park, NM. A modified commercial-type roller-gin stand was operated in the laboratory at ginning rates up to five times normal, comparable to that of the conventional saw gin. Roller gins are used on extra-long-staple cottons such as American Pima to minimize neps and fiber length changes associated with use of saw gins on these cottons.

Wet scrubbing to reduce cotton gin particulate emissions - Mesilla Park, NM. Cotton gins may need to use secondary air cleaning to meet the national Clean Air Act requirements, particularly when processing rough-harvested cotton in the dry Western states. SEA-FR engineers have developed a wet scrubber that in field trials operated at cleaning efficiencies over 90 percent.

New trash-collecting and air-filtering system developed for cotton gins - Stoneville, MS. The Unifier trash-collecting system, with filtration efficiency exceeding 99%, has proven to be an accepted alternate means of abating air pollutants from cotton ginning systems. Developed by SEA scientists, it is being manufactured and sold in foreign countries as well as in the U.S.

Energy conservation system developed for cotton gins - Stoneville, MS. SEA scientists have developed and released to the ginning industry a system for incinerating of cotton gin wastes and reclaiming heat for drying seed cotton concurrent with ginning. This system can reclaim and deliver 30 percent of the heat from combustion to the gin driers.

Quieter brush cylinder developed - Stoneville, MS. A new spiral-wound brush cylinder has been designed by SEA scientists which lowers noise levels in cotton ginning systems. In operation, the new cylinder produces 88 percent less noise than the standard brush, doffs cotton more efficiently, and uses less electrical energy.

Moisture restoration at cotton gins automated - Stoneville, MS. SEA scientists have developed two automatic systems for restoring normal moisture to cotton fibers following ginning. Restoration of normal moisture content preserves fiber quality, eliminates static electricity, minimizes bale weight changes and reduces energy in baling.

Wet harvested cotton should be ginned without delay - Stoneville, MS. Research has shown that cotton harvested at night or before dew is evaporated may contain sufficient moisture to permit growth of harmful fungi and subsequent development of aflatoxin in cottonseed if such cotton is not ginned within 5 days. Thus it is advisable to store for longer periods only that cotton which has been harvested when relative humidity is below about 55%.

Cotton dust control - Clemson, SC. SEA research has shown that textile mill compliance with strict OSHA cotton dust standards in early yarn processing operations can best be achieved by combining optimum dust capture and removal systems with the use of mineral oil additives to hold down dust generation. Results are currently being utilized by industry in both direct application and in research.

Grain dust control - Clemson, SC. A laboratory system and procedure was developed by SEA scientists to study effects of adding small amounts of oil to grain to reduce dust in grain handling systems. Initial tests showed that as little as 0.1% of oil added to grain can reduce dust generation by 90% or more. Use of oil additives to control grain dust generation holds potential for reducing explosion hazards at grain elevators and for improving environmental air quality.

Wet-wall precipitator shows potential for controlling cotton dust - New Orleans, LA. The efficiency of operation and simplicity of design of the Wet-Wall air cleaner developed by SEA scientists have attracted the interest of the textile air cleaning industry, and it is expected that a full-scale industrial machine will be tested during 1978. The development will help mills meet the new OSHA cotton dust standards.

Newsprint made from kenaf - Peoria, IL. Newsprint from 100% kenaf fiber has been prepared and tested in a commercial printing run by the Peoria Journal Star in cooperation with SEA scientists. The development holds significance because 60-70% of U.S. newsprint requirements are now imported. Kenaf provides an agricultural alternative to trees as a source for chemical pulp and newsprint, producing up to 5 times more pulp per year per acre.

Technological Objective 3:

Develop new and more effective systems for converting natural fibers into yarns, webs, and fabrics.

Research Locations:

New Orleans, Louisiana

Selected Examples of Recent Progress:

Vented rotors reduce maintenance requirements on open-end spinning - New Orleans, LA. The vented open-end spinning rotor developed by SEA scientists has been shown to be effective for reducing dust accumulation during open-end spinning. Limited testing under actual mill conditions shows that cleaning frequency can be reduced by at least half.

Rapid method for determining open-end yarn twist - New Orleans, LA. Conventional methods for determining yarn twist are not easily applied to open-end spun yarns. SEA scientists have developed a rapid method for determining twist in open-end spun yarns. The new method is based on producing a striped appearance by feeding a white and a black sliver simultaneously into the spinning rotor.

Technological Objective 4:

Develop new and more effective systems for converting yarns, webs and fabrics into finished textiles and products.

Research Locations:

Albany, California  
New Orleans, Louisiana

Selected Examples of Recent Progress:

Vapor-phase process for shrinkproofing wool garments - Albany, CA. Earlier research by SEA scientists showed that felting shrinkage of wool can be effectively reduced by exposure to ozone. A novel use of this vapor-phase process is being developed for treating finished garments by exposure to ozone and steam for a few minutes in a special chamber. The process appears to be particularly useful for treating knitted wool sweaters to make them machine-washable.

Water purification with crab shell - Albany, CA. The natural polymer chitin found in large amounts in crab shell has been found by SEA scientists to be highly effective in removing heavy metal pollutants from water when the chitin is modified by chemical treatment. The modified chitin is especially effective in removing toxic hexavalent chromium from waste water from textile dyeing and from electroplating baths. After becoming charged with the heavy metal ions, the polymer can easily be regenerated after which it is ready for reuse.



New plastic lens lowers the cost of solar energy - Albany, CA. SEA scientists have developed a low cost method for producing fresnel-type solar lenses for converting sunlight to useful energy. A plastic lens is formed directly by extrusion through a specially-formed die in any desired length, thereby significantly reducing the cost of lens production.

Cellulose waste helps stop soil erosion - Albany, CA. Based on the same technology used for producing viscose rayon, cellulose xanthation, SEA scientists have developed a process for treating cellulose-containing waste, such as straw, to help bind soil particles and prevent erosion.

Smolder-resistant cotton upholstery fabrics - New Orleans, LA. SEA scientists have shown that cotton upholstery fabrics can be upgraded from unacceptable "D" class to acceptable "A" or "B" class materials by treatment with methyl borate vapors. The same vapor phase process, heretofore used to smolder-proof cotton batting material for mattress and furniture stuffing, can also be used to impart smolder resistance to home-type cellulosic insulation made from reclaimed paper at significantly lower chemical cost.

Wet-on-wet dyeing process for cotton - New Orleans, LA. Cotton which has been wet-swollen in a mercerizing agent such as aqueous sodium hydroxide or liquid ammonia, and while still wet is passed immediately into an aqueous dyebath, followed by oven drying to trap the dye inside the swollen fibers of cotton, shows greatly increased depth of dyeing.

Speed of liquid pick-up by cotton and other polysaccharides increased via cold plasmas - New Orleans, LA. Cotton textiles subjected to cold plasma treatments at room temperature showed dramatic improvement in their speed of pick-up of water, dye solutions, and oils. This increase in rate of pick-up of solutions by cotton is of potential value in preparing improved toweling, in the production of surgical sponges, and in improving the dispersibility of cotton fibers for processing via wet techniques.

Transfer printing of cotton blend fabrics - New Orleans, LA. SEA scientists have developed two techniques for improving transfer printing of cotton-containing blends. One method involves chemical treatment, the other depends on a modification of a knitted structure. Both developments should help cotton to participate in markets now served mainly by synthetics.

#### Technological Objective 5:

Develop new and improved properties for consumer products made from natural fibers.

#### Research Locations:

Albany, California  
New Orleans, Louisiana

Selected Examples of Recent Progress;

Counting crosslinks - Albany, CA. For the first time, experimental work based on a new theoretical method has shown that the actual concentration of crosslinks joining one molecule to another in wool and other cross-linked proteins can be determined absolutely. This has important applications in understanding and improving the useful properties of wool, such as wrinkle recovery. In addition, it may have valuable applications in protein studies in other branches of science and medicine.

Long-life prosthetic socks - Albany, CA. SEA scientists have developed a resin treatment for all-wool amputee socks which increases the wear life of the socks ten-fold over untreated socks when washed and dried using home washing machines and driers. In cooperation with the Naval Prosthetic Research Laboratory, an extensive wear trial was carried out. Navy doctors checked the test wearers during the trial and found no evidence of skin sensitivity or other medical effects related to the treated socks. The unequalled high moisture absorbancy and resilience of wool, which makes it the most desirable fiber for this purpose, are unchanged by the resin treatment.

Improved wear life of durable press cotton fabrics - New Orleans, LA. Cotton fabrics having substantially better retention of abrasion resistance in combination with attractive levels of durable-press performance were achieved with 3 types of experimental reagent systems. The common feature of these reagent systems was polymerization-crosslinking in the cotton fiber under conditions similar to or approaching those of textile mill operation. These results provide leads toward improved commercial textile products and toward clarification of mechanisms of finishing for improved textile products.

Enhanced protection from FR cotton fabrics - New Orleans, LA. SEA research has shown that cotton fabrics treated for flame retardance provide protection to adjacent untreated cotton fabric during burning. The most effective finish appeared to be the THPOH-ammonia finish. It follows that burn injury to a wearer of such a fabric combination should be less severe than if the combination were made entirely from untreated fabric.

Cotton flame retardance via different routes - New Orleans, LA. SEA research involving pyrolysis mass spectrometer measurements show that several reactions occur simultaneously in the pyrolysis of cotton. These reactions are affected to different extents by the various phosphorus-containing flame retardants.

Quick test for abrasive wear - New Orleans, LA. Possibility of a quick, nondestructive test for predicting some types of abrasive wear in cotton textiles has been demonstrated. Results are based on the successful measurement of sonic velocity through a woven fabric, and correlation with a destructive laboratory test for abrasion.

Treatment of cotton with sulfa drugs - New Orleans, LA. Several sulfa drugs have been found to react with cotton under certain conditions. Such products offer a potential means for making fabrics with enhanced anti-bacterial properties.

Treatment of cotton with hydrogen peroxide complex provides antibacterial and antistaining properties - New Orleans, LA. Formation of the  $H_2O_2$  complex on cotton rendered the fabric resistant to the growth and spreading of infection-producing bacteria as well as to odor-producing bacteria. Treated fabrics also showed substantial inhibition of a fungus causing athlete's foot. Treated white athletic socks showed increased resistance to soiling & increased ease of soil removal during laundering, due to the action of the peroxide finish as a built-in bleach.

Bleach resistant FR cotton - New Orleans, LA. Chloromethyl phosphonic diamide (CMPD) has been shown to be an excellent durable flame retardant for medium weight (7-8 oz.) all-cotton fabrics. Finished fabrics retain FR properties during laundering, even in the presence of hypochlorite bleaching agents.

Bromine-containing cotton flame retardant - New Orleans, LA. A new flame retardant for cotton (TMDABT), developed by SEA scientists, demonstrated that durable flame retardance of cotton can be achieved at low add-ons with a bromine compound without need for additional components such as antimony oxide or phosphorus.

Durable outdoor fire-retardant finishes - New Orleans, LA. Flame retardant finishes for recreational-type cotton fabrics with strength retention and good durability to weathering have been developed. Tests have shown FR properties last for at least two years of continuous outdoor exposure. Finishes of this type hold promise for reducing fire losses and injuries, and should help cotton compete for outdoor and recreational fabric markets.

Elimination of phosphine-like odor - New Orleans, LA. SEA scientists have identified and developed a means for removing the cause of a possible source of disagreeable odors resulting from treatment of cotton fabrics with THPOH flame retardant finishes. Elimination of undesirable odors will improve work area environment and reduce air pollution in the vicinity of processing plants.



PUBLICATIONS

Albany, California

Chauffee, L. and M. Friedman. Factors affecting cyatoborohydride reduction of aromatic Schiif's bases in proteins. In Protein Cross-linking: Nutritional and Medical Consequences, Vol. 86B, pp. 415-424, M. Friedman ed. (Advances in Experimental Medicine and Biology, Vol. 86B) Plenum Publishing Corp., New York. 1977.

Finley, J. W. and M. Friedman. New amino acid derivatives formed by alkaline treatment of proteins. In Protein Crosslinking: Nutritional and Medical Consequences, Vol. 86B, pp. 123-130, M. Friedman, ed. (Advances in Experimental Medicine and Biology, Vol. 86B) Plenum Publishing Corp., New York. 1977

Finley, J. W., J. T. Snow, P. H. Johnston and M. Friedman. Inhibitory effect of mercaptoamino acids on lysinoalanine formation during alkali treatment of proteins. In Protein Crosslinking: Nutritional and Medical Consequences, Vol. 86B, pp. 85-92, M. Friedman ed. (Advances in Experimental Medicine and Biology, Vol. 86B) Plenum Publishing Corp., New York. 1977.

Finley, J. W., J. T. Snow and M. Friedman. Inhibiting the formation of lysinoalanine. U.S. Patent No. 4,035,349, July 12, 1977.

Friedman, M. Crosslinking amino acids - stereochemistry and nomenclature. In Protein Crosslinking: Nutritional and Medical Consequences, Vol. 86B, pp. 1-27, M. Friedman ed. (Advances in Experimental Medicine and Biology, Vol. 86B) Plenum Publishing Corp., New York. 1977.

Friedman, M. Mass spectra of cysteine derivatives. In Protein Cross-linking: Biochemical and molecular aspects, Vol. 86A, pp. 713-726, M. Friedman, ed. (Advances in Experimental Medicine and Biology, Vol. 86A) Plenum Publishing Corp., New York. 1977.

Friedman, M. and W. A. Boyd. A nuclear magnetic double resonance study of N- $\beta$ -bis-( $\beta$ '<sup>r</sup>-chloroethyl)-phosphonylethyl-DL-phenylalanine. In Protein Crosslinking: Biochemical and Molecular Aspects, Vol. 86A, pp. 727-742, M. Friedman ed. (Advances in Experimental Medicine and Biology, Vol. 86A) Plenum Publishing Corp., New York. 1977.

Friedman, M., J. W. Finley and Lai-Sue Yeh. Reactions of proteins with dehydroalanines. In Protein Crosslinking: Nutritional and Medical Consequences, Vol. 86B, pp. 213-224, M. Friedman ed. (Advances in Experimental Medicine and Biology, Vol. 86B) Plenum Publishing Corp., New York. 1977.

Friedman, M. and N. H. Koenig. Modification of wool. U.S. Patent No. 4,007,006, February 8, 1977.

Friedman, M. and L. D. Williams. A mathematical analysis of kinetics of consecutive, competitive reactions of protein amoni acid groups. In Protein Crosslinking: Nutritional and Medical Consequences, Vol.

86B, pp. 299-319, M. Friedman ed. (Advances in Experimental Medicine and Biology, Vol. 86B) Plenum Publishing Corp., New York. 1977.

Gregorski, K. S. An X-ray diffraction study of thermally induced structural charges in alpha-keratin. In Protein Crosslinking: Biochemical and molecular aspects, Vol. 86A, pp. 329-344, M. Friedman, ed. (Advances in Experimental Medicine and Biology, Vol. 86A) Plenum Publishing Corp., New York. 1977.

Koenig, N. H. Chemical modification of wool in aprotic swelling media. J. Appl. Polym. Sci. 24:445-465. 1977.

Koenig, N. H. and M. Friedman. Comparison of wool with selected mono- and bifunctional reagents. In Protein Crosslinking: Biochemical and Molecular Aspects, Vol. 86A, pp. 355-382, M. Friedman ed. (Advances in Experimental Medicine and Biology, Vol. 86A) Plenum Publishing Corp., New York. 1977.

Koenig, N. H. and M. Friedman. Combined application of reactive compounds in nonaqueous swelling solvents for flame- and shrink-resistant wool. Text. Res. J. 47:139-141. 1977.

Koenig, N. H. and M. Friedman. Process for simultaneously flame-proofing and shrinkproofing wool. U.S. Patent No. 4,029,471, June 14, 1977.

MacGregor, J. T. and M. Friedman. Nonmutagenicity of tetrabromophthalic anhydride and tetrabromophthalic acid in the Ames salmonella/microsome mutagenicity test. Mutation Res. 56:81-84. 1977.

Menefee, E. Physical and chemical consequences of keratin crosslinking, with application to the determination of crosslink density. In Protein Crosslinking: Biochemical and Molecular Aspects, Vol. 86A, pp. 307-327, M. Friedman, ed. (Advances in Experimental Medicine and Biology, Vol. 86A) Plenum Publishing Corp., New York. 1977.

O'Connell, R. A., F. J. Ahrens, and C. E. Pardo. Wool/polyester swiss pique feeder blend knits. Knitting Times 46(6):35-37. 1977.

O'Connell, R. A. and Foster, R. E. Process for preparing space-dyed yarn. U.S. Patent No. 4,063,888, December 30, 1977.

Pittman, A. G., W. L. Wasley and N. F. Getchell. Process for rapid dyeing of textiles. U.S. Patent No. 4,056,354, November 1, 1977.

Schellman, J. A. and D. Stigter. Electrical double layer, zeta potential, and electrophoretic charge of double-stranded DNA. Biopolymers 16:1415-1435. 1977.

Stigter, D. Interactions of highly charged colloidal cylinders with applications to double-stranded DNA. Biopolymers 16:1435-1448. 1977.

Tillin, S. J., R. A. O'Connell, A. G. Pittman, and W. H. Ward. The effects of ethylene glycol on wool fibers. In Protein Crosslinking: Biochemical and molecular aspects, Vol. 86A, pp. 383-390, M. Friedman ed. (Advances in Experimental Medicine and Biology, Vol. 86A) Plenum Publishing Corp., New York. 1977.

Wasley, W. L. and A. G. Pittman. Terpolymers of fluoroalkyl ethers and maleic anhydride. U.S. Patent 4,029,867, June 14, 1977.

#### Peoria, Illinois

Bagby, M. O. Kenaf - A Practical Fiber Resource. TAPPI Press Report, Non-Wood Plant Fiber Pulping, Progress Report No. 8, pp. 75-80. 1977.

Touzinsky, G. F., F. L. Baker, R. L. Cunningham, and M. O. Bagby. Scanning Electron Microscopy of Kenaf Paper Structures. J. Agric. Food Chem. 25(4):734-738. 1977.

#### New Orleans, Louisiana

Andrews, B. A. K., G. B. Verburg, A. B. Cooper, and J. G. Frick, Jr. Increased recovery in knitted cotton and cotton blends with comfort stretch. In Clothing Comfort; Interaction of Thermal, Ventilation, Construction, and Assessment Factors, pp. 55-69, N. R. S. Hollies & R. F. Goldman, Editors (The Fiber Society, Inc. Comfort Symposium Proceedings) Ann Arbor Science Publishers, Inc. 1977.

Arthur, J. C., Jr. Editor's Preface, Textile and Paper Chemistry and Technology, ACS Symposium Series No. 49, 304 pp. American Chemical Society, Washington, D.C. 1977.

Arthur, J. C., Jr. Editor's Preface, Cellulose and Fiber Science Developments: A World View, ACS Symposium Series No. 50, 287 pp. American Chemical Society, Washington, D.C. 1977.

Andrews, F. R., C. B. Hassenboehler, Jr., M. L. Nelson, and A. R. Markezich. Length-change phenomena accompanying liquid-ammonia and caustic mercerization. Text. Res. J. 47:670-678. 1977.

Baril, A., Jr., D. P. Thibodeaux, R. Reif, and B. J. Claassen. Research on new equipment for cotton dust collection. Proc. Workshop on Novel Concepts, Methods and Advanced Technology in Particulate-Gas Separation, Notre Dame, Indiana, April 20-21, 1977.

Berni, R. J., M. M. Smith, and R. R. Benerito. Emulsions for flame retardant cotton/polyester blends. J. of Fire Retardant Chemistry 4: 59-67. 1977.

Bertoniere, N. R., S. P. Rowland, and E. J. Roberts. Durable-press properties in cotton-containing fabrics via polymeric N-methylol reagents. U.S. Patent No. 4,011,614, March 15, 1977.



Bertoniere, N. R. and S. P. Rowland. Effectiveness of prepolymers of Tris-(1,3-dichloro-2-propyl) phosphate and polyethyleneimine as flame retardants for cotton-containing fabrics. Text. Res. J, 47:28-86. 1977.

Blanchard, E. J. et al. Novel method for transfer printing cotton textiles. AATCC National Technical Conference Book of Papers, pp. 33-41. 1977.

Blanchard, E. J., J. T. Lofton, J. S. Bruno, and G. A. Gautreaux. Production of chambray and other dyed fabrics through phosphorylation. AATCC National Technical Conference Book of Papers, pp. 257-262. 1977.

Blouin, F. A. and S. P. Rowland. Copolymerization of addition and condensation type monomers for flame retardancy of cotton and blend fabrics. Text. Res. J. 47:789-794. 1977.

Bruno, J. S. and E. J. Blanchard. Economical kiss roll padding. American Dyest. Reprtr. 66(4):46, 47, 50. 1977.

Calamari, T. A., Jr., R. J. Harper, Jr., and S. P. Schreiber. Some novel techniques for producing flame retardant cottons from phosphorus/nitrogen precondensates. AATCC National Technical Conference Book of Papers, pp. 125-127. 1977.

Cashen, N. A. A modified THPOH-ammonia treatment of cotton to impart flame retardancy and antibacterial properties. Text. Res. J. 47:740-745. 1977.

Cashen, N. A. Method of producing anhydrous crystalline reaction products of formaldehyde and methyl-, ethyl carbamate. U.S. Patent No. 4,002,668, January 11, 1977.

Chance, L. H., and J. D. Timpa. 2,4-Diaminotrihalopropyl triazines derived from  $\gamma$ -Trihalobutyronitriles. J. Chem. and Eng. Data 22(1):116-117. 1977.

Chance, L. H., and J. D. Timpa. A new durable non-phosphorus flame retardant for cotton based on Tetramethylol 2,4-diamino-6-(3,3,3-tribromo-1-propyl)-1,3,5-triazine. Text. Res. J. 47:418-422. 1977.

Chance, L. H., and J. D. Timpa. Diaminotrihalopropyl triazines and their methylol derivatives. U.S. Patent No. 4,055,720, October 25, 1977.

Chance, L. H., and J. D. Timpa. 2,4,6-Tris(carbamoyl-methylamino)1,3,5-s-Triazine. U.S. Patent No. 4,006,274, February 1, 1977.

Claassen, B. J. The fluid electrode precipitator--A continuous cleaning electrostatic precipitator. Proc. of the Pollution Control Assoc. Annual Meeting, Paper 77-2.8. Toronto, Canada, 1977.

Claassen, B. J., and D. P. Thibodeaux. USDA research to develop an air cleaner to remove respirable dust from cotton mills. Proc. Special Session on Cotton Dust, 1977 Beltwide Cotton Production Res. Conf., Atlanta, Ga., January 10, 1977.

Daigle, D. J., A. B. Pepperman, and S. L. Vail. Treatment of organic textiles with adduct polymers and phenols. U.S. Patent No. 4,017,462, April 12, 1977.

Evans, W. J., V. L. Frampton and A. D. French. A comparative analysis of the interaction of mannitol with borate by calorimetric and pH techniques. J. Phys. Chem. 81:1810-1812. 1977.

Elgal, G. M., R. M. Perkins, and N. B. Knoepfler. Prepolymer preparation and polymerization of flame retardant chemicals in cotton fabrics. Amer. Chem. Soc. Symposium Series 58, pp. 249-260. 1977.

Folk, C. L. Self-cleaning open-end yarn spinning apparatus. U.S. Patent No. 4,005,568, February 1, 1977.

Folk, C. L. Retracting tooth processing cylinder apparatus. U.S. Patent No. 4,043,004, August 23, 1977.

Folk, C. L. and J. I. Kotter. Fiber blending, subdividing and distribution system. U.S. Patent No. 4,030,280, June 21, 1977.

Frank, A. W. The iodometric determination of P(III) in flame retardants for cotton, part IV: Reaction of THPC with iodate. Text. Res. J. 47: 60-61. 1977.

Frank, A. W., and G. L. Drake, Jr. Synthesis and properties of carbamate derivatives of tetrakis (hydroxy-methyl) phosphonium chloride. J. Org. Chem. 42:4040-4045. 1977.

Frank, A. W. and G. L. Drake, Jr. Disproportionation of tetrakis (anilonomethyl)phosphonium chloride in ethanol. J. Org. Chem. 42:4125-4127. 1977.

Franklin, W. E., J. P. Madacsi, and S. P. Rowland. Creasable durable press textiles from methylol reagents and half amides or half salts of dicarboxylic acids. U.S. Patent No. 4,061,465, December 6, 1977.

Franklin, W. E. and S. P. Rowland. High molecular weight acidic polymers. U.S. Patent No. 4,024,099, May 17, 1977.

Franklin, W. E., C. P. Wade, and S. P. Rowland. Postactivation catalysts for recurability of DMDHEU-glycolic acid durable-press fabrics. Text. Res. J. 47:317-323. 1977.

French, A. D. and V. G. Murphy. Computer modeling in the study of starch. Cereal Foods World 22:61-70. 1977.

French, A. D. and V. G. Murphy. Intramolecular changes during polymorphic transformations of amylose. Polymer 18:489-494. 1977.

French, A. D. and V. G. Murphy. A virtual bond modeling study of cellulose I. Cellulose Chemistry and Technology. American Chemical Soc. Symposium Series 48:12-29. 1977.

Graham, C. O., P. L. Rhodes, and R. J. Harper, Jr. Processing Cotton with chemically altered fiber friction. Text. Res. J. 45(2):102-106. 1977.

Graham, C. O. and P. L. Rhodes. Combing of opening room blends of cotton and polyester. American Society of Mechanical Engineers Tech. Pub. 77-Tex-5:1-5. October 1977.

Harper, R. J., Jr., J. S. Bruno, and G. A. Gautreaux. Modifying the electrical resistivity of durable-press fabrics. Text. Res. J. 47(5): 340-347. 1977.

Harris, J. A., J. C. Arthur, Jr., O. Hinojosa, G. J. Boudreaux, and E. R. McCall. Synthesis of some furoic and thenoic esters of the methyl D-glucopyranosides and their stability to high energy radiation. Carbohyd. Res. 53:57-66. 1977.

Hobart, S. R. and C. H. Mack. Interaction of flame-retardant and untreated cotton fabrics during burning. Text. Res. J. 47:351-360. 1977.

Hobart, S. R., C. H. Mack and S. P. Rowland. Flame-retardancy transfer from FR cotton fabric to cotton/polyester blends. Text. Res. J. 47: 394-397. 1977.

Jung, H. Z., R. R. Benerito, R. J. Berni, and D. Mitchum. Effect of low temperatures upon polymorphic structures of cotton cellulose. J. Applied Poly Sci. 21: 1981-88. 1977.

Jung, H. Z., T. L. Ward, and R. R. Benerito. The effect of argon cold plasma on water absorption of cotton. Text. Res. J. 47:217-23. 1977.

Jung, H. Z., T. L. Ward. Water absorption of toweling as affected by argon cold plasma. Text. Res. J. 47:563-64. 1977.

Kingsbery, E. C., G. F. Ruppenicker, C. O. Graham, G. J. Kyame, J. T. Lofton, and P. L. Rhodes. Wear trials on easy care cotton work trousers. American Dyestuff Reporter, December 1977.

Knoepfler, N. B., W. T. Gentry, and J. P. Madacsi. Resistance of mattresses containing boric acid treated cotton batting to open flame ignition. J. Consumer Product Flammability 4:169-187.

Knoepfler, N. B. and J. P. Madacsi. Interim progress report IX on research to develop flame retardant cotton batting products. SRRC, ARS, USDA processed publication, 54 pp. 1977.

Knoepfler, N. B., J. P. Madacsi, and J. P. Neumeyer. A vapor phase process to impart smolder resistance to cotton batting and other cellulosic materials. U.S. Patent 4,012,507, March 15, 1977.



Kotter, J. I., A. Baril, Jr., and C. L. Folk. Integrated yarn production system: SRRC tuft to yarn, Part 1. Engineering Design, Symposium About the Technical Advances of Spinning, pp. 8.01-8.10. Sponsored by: The Institute of Textile Investigation and of Industrial Cooperation of Tarrasa, Spain, March 22-24, 1976.

Kotter, J. I. and C. L. Folk. Method and apparatus for producing yarn from fibrous tufts. U.S. Patent No. 4,028,872, June 14, 1977.

Kullman, R. M. H., and R. M. Reinhardt. Durable press finishing of cellulose-containing textiles with aluminum chlorhydroxide-hydrogen peroxide catalyst system. U.S. Patent No. 4,039,282, August 2, 1977.

Lyons, D. W., A. El-Nashar, S. L. Vail, and A. B. Pepperman, Jr. Migration of FR finishes during drying of cylindrical cotton samples. Text. Chem. Color. 9:86-89. 1977.

Madacsi, J. P., N. B. Knoepfler, and J. P. Neumeyer. Vapor phase deposition of boric acid on cotton fibers via borate esters 1., static atmosphere. J. Fire Retardant Chem. 4:73-93. 1977.

Madacsi, J. P., N. B. Knoepfler, and J. P. Neumeyer. Vapor phase deposition of boric acid on cotton fibers via borate esters 2., dynamic atmosphere. J. Fire Retardant Chem. 4:242-258. 1977.

Mares, T., J. C. Arthur, Jr., and J. A. Harris. Single treatment process for imparting durable soil release properties to cotton and cotton-polyester blend fabrics. U.S. Patent 4,063,885, December 20, 1977.

Margavio, M. F., A. B. Pepperman, Jr., L. A. Constant, E. J. Gonzales, and S. L. Vail. A chlorine bleach resistant durable flame-retardant finish for cotton based on chloromethyl phosphonic diamide. J. Fire Retardant Chemistry, 4:192-206. 1977.

Margavio, M. F., and J. D. Guthrie. Aminization of cotton fabric by slow dry curing. Text. Res. J. 47:52-55. 1977.

Mod, R. R., J. A. Harris, J. C. Arthur, Jr., F. C. Magne, G. Sumrell, and A. F. Novak. Process for the preparation of phosphonated N,N-disubstituted fatty amides. U.S. Patent 4,008,137, February 15, 1977.

Mod, R. R., J. A. Harris, J. C. Arthur, Jr., F. C. Magne, G. Sumrell, and A. F. Novak. Heterocyclic fatty amides. U.S. Patent No. 4,062,841, December 13, 1977.

Moreau, J. P., J. V. Beninate, and G. L. Drake, Jr. THPOH-NH<sub>3</sub> flame retardant: Its effect on cotton blends. J. Fire Retardant Chemistry 4:6-17. 1977.

Morris, C. E., L. Segal, and G. L. Drake, Jr. Effects of Hospital Laundering and Sterilization on FR fabrics. Part III., Man-made fiber fabrics laundered with bleach. Amer. Dyest. Repr. 66(10):54-59. 1977.

Pepperman, A. B., Jr., S. L. Vail, and D. W. Lyons, Microwave drying of FR cotton fabrics. Text. Chem. Color, 9:137-141. 1977.

Perrier, D. M., R. R. Benerito. Electron donor properties of tertiary amines in cellulose anion exchangers. In ACS Symposium Series No. 48 entitled Cellulose Chemistry and Technology, pp. 244-55, J. C. Arthur, Jr., ed. ACS Publishing Co. 1977.

Reinhardt, R. J., and R. M. H. Kullman. Sulfonic acids and sulfonate salts as catalysts in durable press finishing. Text. Res. J. 47:181-186. 1977.

Reinhardt, R. M., D. J. Daigle, and R. M. H. Kullman. Durable press finishing with catalysis by Triazaphosphaadamantane derivatives. U.S. Patent No. 4,018,950, April 19, 1977.

Rowland, S. P. Cellulose: Pores, internal surfaces, and the water interface. In Textile and Paper Chemistry and Technology. ACS Symposium Series No. 49, pp. 20-45. American Chemical Society, Washington, D.C. 1977.

Rowland, S. P. Textiles flame retarded with hydroxy-methylphosphorus compounds in combination with Poly(ethyleneurea) and Poly(N-methylolethyleneurea). U.S. Patent No. 4,045,173, August 30, 1977.

Rowland, S. P. and J. S. Mason. Development of Resilience and retention of strength and abrasion resistance in durable-press treated flame retardant cotton fabrics. Text. Res. J. 47:721-728. 1977.

Rowland, S. P. and J. S. Mason. Textile performance properties of cotton fabric treated with selected flame retarding finishes. Text. Res. J. 47:365-571. 1977.

Ruppenicker, G. J., Jr., E. C. Kingsbery, and N. A. Bouquet, Jr. Selection of optimum fiber properties for cotton knits. Textile Res. J. 47(4):239-243. 1977.

Segal, L., C. E. Morris, and G. L. Drake, Jr. Effects of hospital laundering and sterilization on FR fabrics, Part II., cotton and cotton - polyester fabrics laundered with bleach. Amer. Dyest. Reprtr. 66(1):39-44, 52-54. 1977.

Segal, L. and G. L. Drake, Jr. Effect of flame-retardant fabrics on diagnostic radiographs. Bull. N.Y. Acad. Medicine 53:725-730. 1977.

Segal, L. and G. L. Drake, Jr. Mushroom tester. Text. Chem. Color. 9:244-245. 1977.

Soignet, D. M., F. Normand, and R. R. Benerito. ESCA determination of trivalent phosphorus at various stages of flame retardant finishing of cotton. J. of Fire Retardant Chemistry 4:112-22. 1977.

Soignet, D. M., G. J. Boudreaux, J. B. Stanley, and W. L. Thornsberry. Analytical methods for determination of the concentration ratio in a mixture of trioctylphosphine oxide and Di-(2-Ethylhexyl)Phosphoric acid. Anal. Letters 10:625-638. 1977.

Soignet, D. M. Characterization of chemically modified cottons by ESCA in characterization of metal and polymer surfaces, Vol. 2, Characterization of Polymer Surfaces, pp. 73-86. Leign-Huang Lee, ed., Academic Press, Inc., New York. 1977.

Stworzewicz, T., B. Czapkiewicz-Tutaj, and M Leszko. Zesz. Nauk. Univ. Jagiellonskiego, Chemia 22:103-113. 1977.

Stworzewicz, T., B. Czapkiewicz-Tutaj, and M. Leszko. Ion Selective Electrodes, E., E. Pungor, Akademiai Kiado. 1977.

Thibodeaux, D. P., J. I. Kotter, and A. Baril, Jr. Integrated yarn production system: SRRC tuft-to-yarn, Part II. Analysis of Fiber Handling and Yarn Production, Symposium About the Technical Advances of Spinning, pp. 9.01-9.09. Sponsored by: The Institute of Textile Investigation and of Industrial Cooperation of Tarrasa, Spain, March 22-24, 1976.

Trask, B. J., T. A. Calamari, Jr., and R. J. Harper, Jr. Liquid ammonia stabilization of cotton denim. Text. Chem. Color. 9:237-239. 1977.

Vail, S. L. Summary of recent studies in chemical finishing of cotton. Internatl. Dyer and Text. Printer 157:558-560. 1977.

Varghese, J. and D. M. Pasad. Role of preparatory processes on crease recovery and strength-abrasion characteristics of DMEU finishes cotton fabrics. Proc. 18th Technological Conf., ATIRA, BTRA and SITRA, pp. 19.1-19.10. 1977.

Varghese, J., D. M. Pasad, S. W. Bandekar, and S. R. Dixit. Role of wet processing on strength-abrasion traits of cotton drill and poplin. Indian Text. J. 87:151-162. 1977.

Varghese, J., D. M. Pasad, S. S. Pakhale, and S. R. Malaviya. Studies on chemically modified cotton fabrics: Part I - Chemical and physical properties of hydrocellulose and peroxide and hypochlorite oxycellulose. Indian J. Text. Research 2:37-44. 1977.

Varghese, J., D. M. Pasad, P. B. Patel, and S. W. Bandekar. Studies on chemically modified cotton fabrics: Part II - Chemical and physical properties of DMEU-finished hydrocellulose and peroxide and hypochlorite oxycellulose. Indian J. Text. Research 2:45-52. 1977.

Vigo, T. L., G. F. Danna, and C. M. Welch. Antibacterial cotton fabrics containing peroxide complexes of zirconyl acetate. Textile Chem. Color. 9:77-80. 1977.



- Wade, C. P., W. E. Franklin, and S. P. Rowland. Recurability and textile properties of postactivated cotton and blend fabrics. Text. Res. J. 47:440-445. 1977.
- Wade, C. P. and S. P. Rowland. Cellulose reagents incorporating T-amino groups. U.S. Patent No. 4,017,259, April 12, 1977.
- Ward, T. L. and R. R. Benerito. Grafting of cyclic carbamates onto cotton and modified cottons. J. Applied Poly Sci. 21:1933-44. 1977.
- Ward, T. L., R. R. Benerito and J. J. Hebert. Process for etching glass on ceramic surface. U.S. Patent No. 4,013,493, March 1977.
- Ward, T. L., R. R. Benerito, and J. J. Hebert. Method of forming glassy materials from plumbites and cellulose. U.S. Patent No. 4,029,533, June 14, 1977.
- Ward, T. L., R. R. Benerito and J. J. Hebert. Glassy materials from plumbites and cellulose. U.S. Patent No. 4,046,953, September 6, 1977.
- Weiss, L. C. and D. P. Thibodeaux. Cotton as an electret. Textile Res. J. 47:471-476. July 1977.
- Yatsu, L. Y. and T. P. Hensarling. New photomicrography method. Bioscience 27:744. 1977.

#### Stoneville, Mississippi

- Anthony, W. Stanley. Reduction of lint cleaner brush noise. Tech. Proc. of National Noise and Vibration Control Conf., pp. 181-189. March 1977.
- Anthony, W. Stanley. Effects of repetitive compression on lint-cotton packaging. ARS-S-159, 9 pp. 1977.
- Anthony, W. Stanley, and O. L. McCaskill. Gin noise: How much? Where? What to do? The Cotton Ginners' Jour. & Yearbook 45:1:38-42. 1977.
- Anthony, W. Stanley, and J. M. Simcox. Comparison of the compressive and resilient forces of cotton lint and linters. Oil Mill Gazeteer 81(10): 20-25. 1977.
- Garner, W. E. Varied tests aid in increasing gin efficiency. 1977 Cotton International, 44th Annual Edition, pp. 84-86. 1977.
- Griffin, A. C., Jr. Quality control with high capacity gin stands. The Cotton Ginners' Journal & Yearbook 45(1):25, 28, 29. 1977.
- Griffin, A. C., and H. W. Schroeder. Aflatoxin in cotton after harvesting. Phytopathology 68:119-122. 1978.
- Luckett, K., J. M. Anderson, and S. T. Rayburn, Jr. Comparison of a spindle picker & brush-roll stripper for harvesting cotton on mixed clay soils. Proc. 1977 Beltwide Cotton Prod. Res. Conf., pp. 128-129. Atlanta, Ga., January 10, 1977.

Luckett, K., J. R. Williford, and S. T. Rayburn, Jr. The effects of fertilizer rates, row patterns and bed widths on yield and fiber quality. Proc. of 1977 Beltwide Cotton Prod. Res. Conf., pp. 125-126. Atlanta, Ga., January 10, 1977.

Mangialardi, G. J., Jr., and A. C. Griffin, Jr. A method for restoring moisture to cotton at gins. Trans. ASAE 20(5):979-984. 1977.

Mangialardi, G. J., Jr. Air requirements for conveying seed cotton through gin driers. ASAE Paper No. 77-1540, 11 pp. 1977.

Mangialardi, G. J., Jr. Conserving energy, reduce volume of air to transport and dry seed cotton. The Cotton Ginners' Jour. & Yearbook, 45(1): 13, 14, 16, 18. 1977.

Mangialardi, G. J., Jr. Lint retriever for cotton gins - a progress report. The Cotton Gin & Oil Mill Press 78(21):12-13. 1977.

McCaskill, O. L., R. A. Wesley, and W. S. Anthony. Heat recovery from incineration of gin waste. The Cotton Gin & Oil Mill Press 78(18):12, 14, 16. 1977.

McCaskill, O. L., R. A. Wesley, and W. S. Anthony. Progress of incineration research at Stoneville. Proc. Gin-Waste-Utilization & Stick Seminar, Cotton Incorporated, Memphis Tennessee, 4:8(WU-2):11-15.

Morey, P. R., R. M. Bethea, E. B. Williamson, W. E. Garner, and M. C. Battigelli. Effect of chemical defoliation on leaf and bract content in raw cotton. Am. Ind. Hyg. Assoc. J. 38:364-370. 1977.

Wesley, R. A. Dust levels and particle-size distributions in cotton ginning systems. Proc. Special Session on Cotton Dust, 1977 Beltwide Cotton Prod. Res. Conf., pp. 21-24.

Wesley, R. A., W. S. Anthony and O. L. McCaskill. Utilizing gin trash as a source of energy. Proc. of Special Session on Energy, 1978 Beltwide Cotton Prod. Res. Conf., p. 62. January 1978.

#### Mesilla Park, New Mexico

Kirk, I. W. and C. G. Leonard. Modified saw-type lint cleaner for roller gins. Trans. of the ASAE, Vol. 20, No. 4. 1977.

Kirk, I. W., C. G. Leonard, and D. F. Brown. Air quality in saw and roller gin plants. Trans. of the ASAE, Vol. 20, No. 5. 1977.

Kirk, I. W., C. K. Bragg, E. F. Young, and J. E. Ross. Ginning and spinning performance of standard and pubescent strains of American pima cotton. USDA PRR No. 171. August 1977.

Clemson, S.C.

- Barker, R. L. and D. W. Lyons. Instrumented analysis of the influence of non-lint trash and lint color on the grading of cotton. Textile Res. J. 47(4):289-294. 1977.
- Cocke, J. B., I. W. Kirk, and R. A. Wesley. Spinning performance and yarn quality as influenced by harvesting, ginning and mill processing methods. USDA Marketing Res. Rpt. 1066. 1977.
- Cocke, J. B. Some factors influencing card room dust levels. Proc., Special Session on Cotton Dust, 1977 Beltwide Cotton Production Research Conf., pp. 36-38.
- Cocke, J. B., C. K. Bragg, and I. W. Kirk. Influence of gin-lint cleaner combination and mill cleaning on dust levels and yarn quality of acala cotton. USDA Marketing Res. Rep. 1064. 1977.
- Cocke, J. B., R. A. Wesley, and I. W. Kirk. Harvesting and processing factors affecting dust levels in the card room. USDA Marketing Res. Rep. 1065. 1977.
- Graham, J. S., and C. K. Bragg. Effects of spindle centering on ring-spinning tension. Trans. ASME, J. of Engr. for Ind. 99(1):51-55. 1977.
- Griffin, A. C., Jr., J. D. Hatcher, and J. B. Cocke. Card room dust levels and response of humans to raw cotton cleaned by the Shriley Analyzer. Textile Res. J. 47(2):129-131. 1977.
- Lee, F. D., R. F. Walker, and J. D. Hatcher. Fine particles of cotton dust influence histamine release. Int. J. of Occup. Health & Safety 46(4): 42-45.
- Lyons, D. W., and R. L. Barker. Comparative analysis of trash contamination in cotton by optical scanning. Trans. ASME, J. of Engr. for Ind. 99: Series B, No. 1, pp. 46-50. 1977.
- Perkins, H. H., Jr. Effects of roller ginning conditions on the spinning quality of acala and pima cottons. USDA Prod. Res. Rep. 174. 1977.
- Lubbock, Texas
- Baker, R. V. Performance evaluation on high capacity lint cleaners. Cotton Ginners' Jour. & Yearbook 45(1):5-12. 1977.
- Baker, R. V., E. P. Columbus, and J. W. Laird. Cleaning machine-stripped cotton for efficient ginning and maximum bale values. USDA-ARS Tech. Bull. 1540. 19 pp. 1977.
- Laird, J. W. and J. D. Anderson. Better doffing: Less noise. Cotton Ginners' Jour. & Yearbook 45(1):30-37. 1977.
- Laird, J. W., J. D. Anderson, and W. R. Grub. Noise levels of lint doffing brushes. Trans. ASAE 20(1):182-188. 1977.



ANNUAL REPORT  
FY 1977

National Research Program 20580

TECHNOLOGIES FOR MARKETING--FRUITS, VEGETABLES, SEEDS, NURSERY, AND  
FLORAL PRODUCTS

This is one of the National Research Programs that form the ARS contribution to the Department's mission on Agricultural Marketing and Distribution. NRP 20580 involves basic and applied research concerned with the measurement, improvement, and protection of the quality of horticultural crops, including fruits, vegetables, nuts, seeds, nursery, and floral products, in the marketing channels. The work encompasses physiological, biochemical, and pathological problems encountered during harvest, storage, transport, and distribution of horticultural commodities, the influence of preharvest conditions on the occurrence of these problems, and the development of new methods and devices for measuring and characterizing quality. This program is concerned with the physical distribution costs of marketing horticultural products from farm to consumer. The functions involved are harvesting, assembling, preparing for market, processing, packaging, precooling, loading, transporting, unloading, storing, warehousing, and wholesale and retail distribution.

NPS Contact: (D. L. Anderson, Interim)      PACS Contact: C. Golumbic

Technological Objective 1.

Develop new and improved technologies for maintaining product quality and reducing losses in marketing channels.

Research Locations:

Albany, California	Chicago, Illinois
Fresno, California	Orono, Maine
Riverside, California	Beltsville, Maryland
Brandenton, Florida	E. Lansing, Michigan
Miami, Florida	E. Grand Forks, Minnesota
Orlando, Florida	New Brunswick, New Jersey
Athens, Georgia	Raleigh, North Carolina
Byron, Georgia	Weslaco, Texas
Hilo, Hawaii	Wenatchee, Washington

Selected Examples of Recent Progress:

Fruits and Vegetables

More rapid hormone assay methods - Albany, CA. Development of new and quicker assay procedures for plant hormones will allow better understanding of the intricate interrelationship of hormones during maturation and senescence of plants, either preharvest or postharvest. Haptens were synthesized to prepare antibodies for spin-label or radiochemical immunoassays of indoleacetic acid (auxin) and gibberelic acid, GA<sub>3</sub>. A mung bean assay is less sensitive but more rapid than current callus tissue assays.

Improved separation of radioactive photosynthate achieved by adapting thin-layer chromatograph - Albany, CA. In the process, a new device for collection and transfer of radioactive zones has been developed. It was found that elevated carbon dioxide levels increase photosynthesis and decrease photorespiration in alfalfa. Ammonia was found to increase the production of amino acids.

Methods for separation of gibberellins developed, useful in metabolic studies - Albany, CA. Separation of gibberellins by argentation high-pressure liquid chromatography was developed. It is based on their conversion to p-nitrobenzyl esters and detection by ultraviolet absorption. Argentation thin-layer chromatography also was applied to the identification of gibberellin esters. The two new methods give complementary information, particularly in case of analogs differing only by a double bond.

Reduction of chilling injury and ripening of Honey Dew melons at low temperatures - Fresno, CA. Gassing Honey Dew melons with ethylene prior to their storage at temperatures that generally induce chilling injury (CI) and prevent ripening, reduced the incidence of CI by about 75% and permitted gradual ripening to occur. Eventual commercial use of this practice would help reduce losses in long-distance shipments of Honey Dews and thus would encourage increases in exports, especially to Asia.

Identification of factors contributing to aflatoxin in almonds - Fresno, CA. Damage from Navel Orange Worm larvae, high orchard temperatures (up to 150°F) during drying, and the absence of competing fungi increased the potential for contamination of almonds with aflatoxin. The use of cultural practices that reduce worm populations, elimination of wormy nuts during processing, and cultural practices that favor competing fungi would reduce the threat of aflatoxin contamination.

Energy savings through use of controlled atmospheres for nut crops - Fresno, CA. Almonds are generally stored in refrigerated warehouses for several months before marketing. The lowered temperatures prolongs storage life and reduce rancidity. Storage for up to a year at room temperature in an atmosphere high in carbon dioxide provides nuts with quality equal to those in refrigerated storage, thus saving the energy used for refrigeration. Gas-tight bags or package liners were used to maintain the desired atmospheres during storage.

Improved storage of dates under refrigeration - Riverside, CA. Commercial practice in the date industry has been to store Deglet Noor dates outdoors under polyethylene until they can be processed. Outdoor storage may last for 1-5 months. SEA scientists found loss of quality in dates was less in refrigerated storage than in outdoor storage. Recommended storage practices in the industry now limit holding dates at ambient temperature to 1 month. Date losses are reduced and quality is improved by refrigerated storage.

Hot water-fungicide dip controls mango diseases - Miami, FL. Research showed that a 1-minute postharvest treatment of 'Keitt' and 'Tommy Atkins' mangos in a suspension of 0.1% benomyl at 126°F provided substantial control of

the diseases (anthracnose and stem-end rot) causing most losses during marketing. Plans have been made to confirm the results and apply for a use permit by the mango industry.

Shipping quality of watermelons - Orlando, FL. In cooperation with the Florida Agricultural Research Center at Leesburg, watermelons were found to retain quality longer if a vigorous fungicide field-spray program is followed during the month previous to harvest. The Charleston Grey cultivar, and an unnamed Florida breeding line developed much less decay when sprayed 3 times during the month than those sprayed only once. A temperature of 15°C was also found to be optimal for holding or shipping. Under these conditions, watermelon quality was maintained sufficiently for storage or export market.

Growth regulator sprays hasten ripening and improve quality of blueberries - Athens, GA. Plant growth regulators succinic acid-2, 2-dimethylhydrazide (daminozide, SADH) and 2-chloroethyl phosphonic acid (ethephon) brought 95% of the blueberries to full ripeness by the date of harvest while control bushes yielded only 36%. The ethephon spray also accelerated fruit abscission. The growth regulators increased the blue color and improve the quality of the fruit. The SADH-ethephon treatment drastically suppressed the rate of softening of stored berries and was positive in extending the storage life. The advanced and concentrated ripening of rabbiteye blueberries will not only be an advantage for mechanical harvesting, but the improved fruit texture from SADH-ethephon will be an asset to fresh market acceptability.

Hydraircooling, a new method of precooling peaches - Byron, GA. Hydraircooling is as effective in precooling fruit and maintaining market quality in storage as are the 2 other methods in current use - hydrocooling and aircooling. Hydraircooling has the advantage of rapidly cooling waxed peaches without washing off the wax coating. This work was done cooperatively with RRRC personnel at Athens, GA.

Waxing peaches - Byron, GA. Waxing decreases respiration and increases internal flesh breakdown of peaches in storage for over 2 weeks. This effect on fruit physiology was not previously recognized, and will be the basis of a closer examination of the limitations of waxing technology on peaches.

New source of an expensive growth regulator - Byron, GA. The fungus *Curvularia lunata* produces 5.8 gm of the growth regulator cytochalasin B from 6 kg of medium. This is an unusually high yield for the chemical which sells on the commercial market at \$8.00/mg. Cytochalasin B is one of the biologically-active metabolites isolated from fungi from weevil-damaged pecans.

Long-term storage of inshell pecans - Byron, GA. Pecans can be held in storage in high CO<sub>2</sub> atmospheres (up to 30%) with no detrimental effect on flavor, and a reduction of kernel discoloration and infection by storage fungi. These preliminary results are the basis for a long-term storage



test now in progress. Economical, long-term storage of pecans could alleviate the marketing problems created by the alternate year bearing habits of pecan trees.

Predicting rancidity on pecans - Byron, GA. The tendency of a pecan variety to become rancid in storage was correlated with high iodine values of the oil. This correlation will be tested again in FY 78, and could be the basis for decisions as to which varieties to process and which to store, and would help geneticists evaluate the commercial desirability of breeding selections.

Improved methods for controlling postharvest decay of papaya - Hilo, HA. Papayas treated with a commercial fruit wax containing 2000 ppm of TBZ (0.5 ml/fruit) remained sound for 7 days at 10°C plus 4-5 days ripening at room temperature 15-25°C.

Causes of resistance to postharvest benzimidazole fungicides studied - Chicago, IL. Two separate and successive induced mutations were needed to bring the fungicide resistance level of Penicillium italicum to that found in marketing channels (>500 ppm). Either ultraviolet (UV) radiation (3500 ergs/mm<sup>2</sup>) or mutagenic chemical treatment (250 ppm N-Methyl-N'-nitro-N-nitrosoguanidine (NTG) for 3 min with 10<sup>7</sup> conidia/ml) induced low order fungicide resistant mutants. NTG, but not UV could induce the high level resistance. A single gene locus is presumed responsible for resistance.

Extent of market losses for fruits and vegetables - Chicago, IL. Selected fruits and vegetables were purchased periodically at 8 representative urban retail stores. Wastage was determined as the portion removed beyond normal paring for table preparation. The percentages discarded in the survey period were as follows: sweet cherries, 10.7%; peaches 20.5%; strawberries, 27.7%; cantaloupes, 18%; lettuce, 8.9%; cucumbers, 6.3%; tomatoes, 13.9%; green peppers, 12.4%; Sweet Spanish onions, 20.2%; Red Delicious apples 9.0%; Anjou and Bartlett pears, 1.3% and 6.1%, respectively.

Brown stain of Sweet Spanish onions - Chicago, IL. Brown staining of outer scales of Sweet Spanish onions in Chicago was associated with gray mold and neck rot. B. allii was frequently associated with brown stain and could induce the disease following laboratory inoculations. Previously, only B. cinerea had been reported as causing brown stain of onions.

Sources of resistance to two Fusarium species found - Orono, ME. A potato clone from the USDA Potato Breeding Program has been found to be highly resistant to two species of Fusarium, F. Coeruleum and F. roseum Sambucinum. When this resistance is incorporated into future varieties, losses to the potato industry would be reduced, thereby, possibly increasing income of growers by over \$60 million per year.

Strawberry with good decay resistance found - Beltsville, MD. 'Earliglow' strawberry was shown to have a high degree of resistance to gray mold (Botrytis spp.), the leading cause of postharvest spoilage. The resistant is lost if the berries are chilled. These studies demonstrating the loss

of decay resistance from chilling, either before or after harvest, are of value in understanding host-parasite interactions. 'Earliglow' is becoming an important commercial variety. It is an important source of germplasm for plant breeders to use in developing improved resistance to gray mold. Until postharvest studies were undertaken, the resistance of 'Earliglow' strawberries to decay was suspected but not proven. (Cooperative research Horticultural Crops Marketing Lab, AMRI and the Fruit Lab, PGGI.)

Mucor--potentially serious storage pathogen - Beltsville, MD. Recent research confirmed 1976 findings that Mucor has become a serious post-harvest fungus disease of fresh produce. Not only are there apparently several species of this microorganism, which infect fruits and vegetables, but the various species grow and infect produce at temperatures normally found in cold storage and in marketing. This year Mucor caused severe decay in pilot-scale controlled atmosphere storage tests of peaches in Maryland and Pennsylvania. The lack of effective control methods make this an extremely important pathogen meriting further research.

New microorganisms causing postharvest decay of tomatoes identified - Beltsville, MD. Two new pathogens causing decay of tomatoes during marketing were isolated and identified as Geotrichum penicilliatum and Mucor circilinoideis. Geotrichum penicilliatum is a potentially serious fungus of fresh market tomatoes. The importance of Mucor circilinoideis appears minor but this remains to be determined. Decay is a major cause of waste in tomato marketing.

Calcium dip controls bitter pit of Summer Rambo apples - Beltsville, MD. Good control of bitter pit, a storage disorder, on Summer Rambo apples was obtained by a brief dip in 2 or 4% calcium chloride solution after harvest. Rambo apples are highly susceptible to the skin-pitting disease called bitter pit. This physiological disease was controlled during both short storage at 10°C and during longer storage (10 weeks) at 0°C. Some skin injury developed from the 4% CaCl<sub>2</sub> dip so a 2% solution is more promising for commercial use on Rambo. Calcium chloride treatment for bitter pit control has been recommended previously by others but not for this variety.

Free radical scavengers reduce susceptibility to chilling injury - Beltsville, MD. The free radical scavengers, sodium benzoate and ethoxyquin, applied as dips, substantially reduced the susceptibility of cucumber and peppers to chilling injury at 2.5°C. Intermittent warming to 20°C for 1-day at 3-day intervals likewise markedly reduced chilling injury symptoms in these vegetables.

Inter-relationship of plant hormones and ethylene studied and their role in senescence - Beltsville, MD. Cortex tissue from apples stored 9 months at 0°C was cultured in a number of different media, to obtain tissue cultures for study of ethylene at the cellular level. A good callus was produced on the medium of Uchimiya and Murashige. Apple tissue suspension cells were formed from this callus. Ethylene production in both the callus and the suspension cells followed a pattern similar to the climacteric rise and fall of ethylene production in ripening fruit. At concentrations

of  $10^{-4}$ M, abscisic acid stimulated and isopentenyl adenosine inhibited ethylene production. Gibberellic acid tended to suppress ethylene production. Greatest stimulation of ethylene production was obtained with IAA and with combinations of IAA and ABA. The stimulatory effect of IAA on ethylene production was suppressed by isopentenyl adenosine or gibberellic acid or combinations of these. In these preliminary studies, the suspension cell cultures offer a promising system for studies of interaction of ethylene with other hormones. The suspension cells may be especially suited for studies of reversion of senescence by hormone treatment.

Role of phosphate in regulating ethylene production - Beltsville, MD.

Inorganic phosphate regulated ethylene production in shake cultures of Penicillium digitatum. Decreasing the phosphate level of the medium from 100 to 0.01 mM, increased ethylene production about 100-fold. Addition of 0.01 and 100 mM phosphate to high ethylene producing, low phosphate cultures, strongly inhibited their ethylene production. Thus phosphate may play an important role in regulating ethylene production in P. digitatum. (Cooperative work with the University of Maryland.)

Decay control treatments developed for fresh and processing carrots -

East Lansing, MI. Cottony soft (Sclerotinia sclerotiorum) and gray mold (Botrytis cinerea) rots of carrots were controlled during 6 1/2 month storage at 4°C by a 10-second postharvest dip in either benomyl or thiabendazole fungicides. Carrots stored at 4°C and 100% relative humidity (RH) had significantly less decay than carrots stored at 90% RH. Moisture loss was significantly less and the carrots remained crisper, firmer, and in better color at the high RH. Label clearance for the postharvest use of benomyl and thiabendazole on carrots for the control of cotton soft and gray mold rots has been requested. This research should greatly enhance the marketing situation for carrots grown in the northern states.

Bulk storage of apples for processing - East Lansing, MI.

Field studies showed that a silo storage is an acceptable way of storing mechanically harvested apples for processing in bulk and without refrigeration. A simple air-cooling system allows for rapid product cooling when climatic conditions are favorable. Quality studies showed silo-stored apples (95 days) compared favorably with refrigerated stored apples. During the storage period the outside air temperatures ranged from a low of -16°C to a high of 12°C, and the mean was -4°C. Prestorage treatment of the fruit with 300 ppm benomyl fungicide prevented decay from increasing during silo storage.

Decay control treatment for 'Concord' grapes - East Lansing, MI.

Results of postharvest disease control studies showed the quality of 'Concord' grapes can be greatly enhanced by treating them in hot water before storing. In tests, grapes held 6 weeks at 2°C were nearly free of mold when treated in hot water (49 to 51.1°C for 1.5 to 5 minutes). Grapes left dry, showed 100% decay (mostly Botrytis).



Increased potato pile pressures measured - East Grand Forks, MN. Higher potato bin wall pressures are being measured than those presently being used by the industry for design. In some instances dry potatoes may cause local, unit pressure twice those previously estimated. Initially after filling, wet potato pressures may exceed those measured for dry potatoes by a factor of about two.

Separation and identification of volatiles from healthy and/or diseased metabolism in potatoes - East Grand Forks, MN. Over 20 volatile hydrocarbons have been identified from healthy potatoes under laboratory and commercial conditions. These compounds are hydrocarbons, C<sub>2</sub> through C<sub>8</sub>, of which olefinic, monocyclic, and branched constituents are present. Their metabolic function remains to be investigated. Volatiles now identified with storage disease stress are as follows: acetone, ethanol, 2-butanone, acetaldehyde, methyl acetate, ethyl acetate, propanethiol, methyl sulfide, methyl disulfide, acetoin, n-propanol, and isobutyl alcohol.

Market losses of fresh tomatoes - New Brunswick, N.J. A 3-year study of market losses of fresh tomatoes retailed in Greater New York was completed. Retail losses totaled 6.7 and 6.3% in bulk and prepackaged tomatoes, respectively. Decay caused 57 and 67% and physical damage 30 and 24% of the losses in bulk and prepackaged fruits, respectively. *Alternaria* rot was the most prevalent rot followed by *Rhizopus* and bacterial soft rots. Losses in consumer samples totaled 4.7 and 7.9% in bulk and prepackaged tomatoes held till ripe. Decay, led by bacterial soft rot, wasted 3.8 and 6.5% of the bulk and prepackaged fruits, respectively.

Treatment to control postharvest decay of blueberries - New Brunswick, N.J. 2-aminobutane (5000 ppm in 100 ppm aqueous NaOCl) dips of blueberries at 0, 3, 6, 9, 12, 15, 24, and 30 hours after inoculation by spore suspensions of *Alternaria*, *Botrytis*, and *Gloeosporium* reduced postharvest rot incidence more than 90% when applied nine hours and 50% when applied 30 hours after inoculation. Similar results were obtained in berries with natural infection.

Controlling fungus diseases of mechanically harvested snap beans - New Brunswick, N.J. *Sclerotinia* and *Pythium* decay were controlled in inoculated mechanically-harvested snap beans by dipping them in heated suspensions of fungicides (chlorine and thiobendazole at 100 and 200 ppm). The two chemicals were effective at 500 and 1000 ppm, however, chlorine caused severe russetting. A hot-water dip (49°C) was less effective but significantly reduced decay.

Internal breakdown of water-harvested cranberries - New Brunswick, N.J. Internal breakdown of water-harvested cranberries in 3°C up to ten weeks was positively related to maturity and length of dwell time (1-30 hours) harvested berries floated in bog. Rate of breakdown was greater when water dwell time was lengthened than when storage time was increased. Regardless of water dwell time, breakdown never exceeded 8% in any lot harvested early (mid-Sept.) yet reached 50% in berries harvested late in October.

Sweet potato storage investigations - Raleigh, N.C. Some sweet potato cultivars appear to be more resistant than others to post-harvest chilling injury. There may also be differences in post-harvest respiration rates and storage rots after wet soil treatments. One week after shipment from North Carolina to Ohio, culinary quality was lower for uncured sweet potatoes than for cured sweet potatoes. Bulk handling of sweet potatoes from field to shed has been shown to be technically feasible. As an alternative to containerized storage, the curing and storage of roots in large piles is being investigated.

Fungicides evaluated for decay control of grapefruit and oranges - Weslaco, TX. Imazalil, 1-[2-(2,4-dichlorophenyl)-2-(2-propenyloxy)-ethyl]-1H-imidazole satisfactorily controlled all major postharvest decays of citrus except Phytophthora parasitica and Geotrichum candidum. In vitro, Imazalil at a concentration of 1 mg/l completely inhibited growth of 17 isolates of Penicillium digitatum and P. italicum resistant to benomyl and thia-bendazole. Imazalil was most effective in controlling postharvest decays of grapefruit when applied at 500 or 1000 mg/l and as a water dip. Imazalil was significantly more effective at suppressing sporulation of P. digitatum than diphenyl when applied to fruit with established decays.

Correlation of postharvest decays of cantaloup to surface netting - Weslaco, TX. Cantaloup fruit were artificially inoculated with Fusarium sp at various stages of net morphogenesis. Pieces of cantaloup rind sectioned and stained showed hyphae of Fusarium penetrated only where the cuticle had recently ruptured during net formation. Once callus tissue began to form, penetration by the fungus was not noted. Fusarium decays of cantaloup apparently become established during early stages of fruit development and progress rapidly only after the melon begins to mature.

Calcium chloride improved firmness and reduced bitter pit of Golden Delicious apples - Wenatchee, WA. Apples from trees receiving a postbloom spray of 50 ppm TIBA had 14% bitter pit and a firmness 0.5 lbs less than the check. Three CaCl<sub>2</sub> sprays on the trees on 6/3, 6/24, and 7/15 controlled bitter pit and produced a firmness 1 lb greater than the check. Post-harvest treatments of the TIBA sprayed fruit with (1) CaCl<sub>2</sub> dip, (2) CA storage, and (3) CaCl<sub>2</sub> dip plus high CO<sub>2</sub> and CA storage increased firmness by 0.5 lbs, 2.5 lbs, and 5.5 lbs, respectively.

Controlling parasitic and non-parasitic diseases of apples - Wenatchee, WA. Diphenylamine (DPA) at 250 and 500 ppm combined with benomyl at 300 ppm in a commercial drencher to Golden Delicious apples controlled senescent scald, but didn't cause the chemical injury found with higher concentrations of DPA. Drenches of benomyl at 300 ppm and Captan at 1440 ppm were not phytotoxic to Red or Golden Delicious apples. Chlorine at 100 ppm was much more effective than SOPP at 6500 ppm in reducing the number of viable spores in dump tanks.

Prestorage treatments for Golden Delicious apples - Wenatchee, WA. After 4 months in CA storage, apples that had been treated for 3, 6, and 9 days with N<sub>2</sub>; 17 percent CO<sub>2</sub>; or 2.5 percent O<sub>2</sub> and 17 percent CO<sub>2</sub> all retained about 3.5 lbs more firmness and 50% more acid than fruit in regular storage.



## Nursery and Floral Products

Cause of leaf scorch (injury) in Easter lilies - Bradenton, FL. Leaf scorch was found to be caused by soil-borne fluoride, a contaminant in ordinary superphosphate. Fluoride availability increases with a decrease in soil acidity with availability increasing sharply below pH 5.5. By using adequate lime, limiting the use of superphosphate and using nitrate fertilizer, soil reaction can be maintained at pH 6.5. Under these conditions the fluoride is unavailable and leaves are not scorched. Leaf scorch was documented 40 years ago but now that the cause is understood the disorder can be controlled effectively.

Sensitivity of foliage plants to ethylene - Bradenton, FL. Foliage plants are sensitive to minute quantities of ethylene gas and on exposure drop leaves, develop twisted petioles and yellow foliage. The symptoms are similar to those normally found in plants that are commercially packaged and shipped. Previously, most injury occurring in transit was believed to be cold damage (chilling injury). Chilling injury symptoms in foliage plants do not resemble the symptoms produced by ethylene toxicity. By knowing specific injury patterns, it is possible for a shipper to determine the probable cause of plant damage during transit and make necessary adjustments in handling and transit procedures to prevent or minimize any future damage.

Senescence inhibitor improves flower vase life - Beltsville, MD. A new senescence inhibitor, the ethoxy analog of rhizobitoxine, extended the vase life of carnations 96%, snapdragons 74%, pompon chrysanthemums 86%, and daffodils and iris 26%, when included as an ingredient of a preservative solution. The beneficial effects of this compound were over and above the effects of sucrose and a quinoline salt in commonly used flower preservative. The influence of rhizobitoxine on cut flowers was found to be different from that of 8-hydroxyquinoline citrate. It lengthens longevity of cut flowers by reducing ethylene production rather than by preventing plugging of the vascular system. (Cooperative research Horticultural Crops Marketing Lab and Post-Harvest Plant Physiology Lab.)

## Seeds

Storage method preserves avocado seeds - Miami, FL. Research showed that 'Lula' avocado seeds treated with 4% captan could be stored in non-perforated polyethylene bags for a year at 5°C with little or no loss in germinability. The method is now used by industry to store 'Lula' avocado seeds from December to September. The seeds are then shipped and planted to fill the demand for avocado rootstocks used for grafting.

Stimulation of seed germination at low temperatures - Beltsville, MD. Fractions that exhibit stimulation of seed germination have been isolated and partially purified. The active fractions appear stable and the material has a low molecular weight. When used for seed germination, they reduce germination time at low temperature by six to eight days. It may be possible to synthesize these compounds after characterization and apply them to seeds in the form of dressing before planting, or introduce them into the seed in order to speed up germination at low temperature.



Effects of fungal infection on planting quality of seed - Beltsville, MD. In 1976, seed-borne fungal infection significantly affected the germinability, vigor, and field emergence of soybean seeds. This demonstrates that these fungi can exert an important negative influence on soybean yield due to their capacity for weakening or killing soybean seeds and thereby reducing field stands.

Regulation of the osmotic potential of seeds - Beltsville, MD. Subtle and important differences in some of the molecular properties (Km, Ki) of the intracellular and extracellular esterases of lettuce seed was identified. The cellular and/or tissue compartmentalization of enzymes with different molecular properties may be of physiological significance in regulating the "intactness" of the seed.

Metabolic activity of seed dormancy factors - Beltsville, MD. The development of a simple quantitative procedure to determine the level of abscisic acid in a single seed has enabled us to perform physiological studies that relate the activity of endogenous hormone or its metabolite to the onset of dormancy or germination.

Relation of stored messenger RNA's to seed germination - Beltsville, MD. Aging treatments had no apparent effect on the in vitro translational activity of messenger RNA's from soybean embryonic axes. Thus, it appears that stored messengers are probably stable. These findings lend support to the concept that the onset of germination may be related to the activation of preformed m RNA's.

Cellular membranes participate in environmental control of seed germination - Beltsville, MD. Studies of the membrane biology of seed germination and dormancy provided the first demonstrations of : (1) The involvement of membranes in the mechanism of seed stratification; (2) light-dependent changes in plasma membrane structure related to photodormancy; and (3) the specific presence of phytochrome, determined immunocytochemically, in cells which first grow in response to light-induced germination. These findings clarify mechanisms of environmental control of seed dormancy and germination.

## Technological Objective 2.

Develop new and improved techniques of quality measurements for use in grading, standardization and inspection programs as a base for consumer protection.

## Research Locations:

Athens, Georgia  
Beltsville, Maryland

## Selected Examples of Recent Progress:

Cause and control of "woodiness" and/or "grittiness" in frozen blueberries - Athens, GA. One of the most serious problems encountered in freezing blueberries is a textural condition known as "woodiness" and/or "grittiness" during storage. It is essential to overcome this problem since woodiness

leaves an objectionable residue in the mouth of the consumer and affects flavor. The "woody" and/or "gritty" texture of berries is caused by the development of sclereids. The freezing methods that prevented or retarded the development of woodiness were the immersion in liquid nitrogen and the pretreatment with the coating mixture, CMC (cellulose gum, gum tragacanth and citric acid) prior to storage at -30°F. This is the first time the actual cause of woodiness was discovered and means of its control found. Expansion of the freezing processes of rabbiteye blueberries will benefit producers and consumers.

Quality of pears determined electronically - Beltsville, MD. The ripening time at various storage temperatures, ripeness, edibility and internal quality condition of pears can be determined by measuring the optical density of the whole fruit with an electronic instrument. Technically the instrument is a multiple-wavelength spectrophotometer which measures, by light transmittance through pears, the changes in water conditions during maturation and ripening. The electronic readings obtained can be used to predict the storage and shelf life of pears at harvest and to detect internal breakdown during grading and marketing. Experiments were conducted with 'Bartlett', 'Anjou', and 'Eldorado' varieties, which provided pears with a wide range of storage life.

Apple quality measured objectively - Beltsville, MD. Sensory qualities of 'Golden Delicious' or 'York Imperial' apples can be estimated objectively by measuring the percentage soluble solids and acid content, the flavor volatile components and textural characteristics. The sensory attributes of apples can be estimated nondestructively by measuring the optical density and vibrational properties, but the accuracy is not as good as with the above destructive techniques. Reliable objective indices of apple quality are needed by USDA regulatory agencies for incorporation into improved Grades and Standards.

Factors affecting fresh tomato acceptability - Beltsville, MD. The sensory quality (flavor, texture) attributes of ripe tomatoes harvested at different stages of maturity were evaluated. A combination of the intensities of acidity, sweetness, saltiness, fruitiness and grassiness played a role in acceptability. Acceptability of table-ripe fruits harvested as breakers (trace yellow or pink color) was slightly better than those harvested as mature-green fruit. A consumer survey indicated that ripe fruits below 30 newtons firmness were too soft and many of those between 40 to 60 newtons firmness were too hard. This limits and helps define the range of firmness that is acceptable to consumers.

### Technological Objective 3.

Reduce costs in distribution and marketing systems by increasing physical efficiency, reducing energy requirements and improving work methods.

#### Research Locations:

Fresno, California  
Gainesville, Florida  
Orlando, Florida  
Athens, Georgia  
Wenatchee, Washington

#### Selected Examples of Recent Progress:

##### Fruits and Vegetables

Comparison of pallet and slip sheet handling of fruit - Fresno, CA. Ten unitized loads of California pears, nectarines, peaches and grapes were shipped to Chicago and compared for mechanical injury and quality maintenance. The use of slip sheets and disposable wooden pallets resulted in similar transit temperatures of fruit shipped by truck (range: 36° to 40°F and 37° to 42°F, respectively). At unloading, about 2.0% of the boxes shipped on slip sheets and 1% of those shipped on wooden pallets showed some damage. The increased damage in slip-sheet loads was due to inexperienced operators of specialized equipment. Fruit quality was the same for the two methods of unitization.

Pallets and slip sheets tested for handling western lettuce - Fresno, CA. Slip sheets allow about a 14% increase in payload over pallets on a highway trailer. The vertical space saved by use of slip sheets increased the height of the load by one layer, thus increasing the number of cartons that can be loaded in a trailer, and reducing energy requirements (per carton) to market lettuce.

Prediction of product cooling response during forced-air cooling of fruits and vegetables - Athens, GA. A computer model was used to provide information on the temperature response during air cooling of fruits and vegetables in bulk loads. Predicted cooling times were developed for wide ranges of variables, including product size, product temperature before cooling, air temperature and flow rate, and size of load. Validity of computer results are backed by experimental data and results have disproven some previously held concepts regarding interaction of air flow and size of load on cooling time.

Semi-automatic machine for trimming sweet corn - Athens, GA. A low cost, semi-automatic machine for trimming sweet corn was constructed and has received preliminary testing at both retail and packinghouse levels. The machine, which is fed by hand, cuts off both ends of the ear leaving a center section of predetermined length. The length of the trimmed ear can be varied depending on the season and cultivar by moving one or both of the cutter blades. During preliminary tests with this equipment, a crate of sweet corn (approximately 56 ears) could be trimmed in less than 2 minutes.



Cooperation with Container Committee of Florida Citrus Packers - Orlando, FL. Prototype handling and shipping containers for citrus were designed for palletizing on standard 120 x 100 cm pallet bases. The boxes were designed to stack in direct vertical alignment, 8 per layer, 7 layers high for a total count of 56 boxes per pallet stack. Polyethylene netting for securing the boxes together in a single pallet unit is being tested. In one shipment, results were satisfactory with respect to stack stability during loading, unloading, and handling. However, the metric boxes caused damage to the bottom layer of fruit where the fruit contacted the gap in the body of the box. The boxes will be redesigned with AFM flaps (all flaps meeting) to eliminate the cause of this damage.

Engineer cooperates with AID on refrigerated storage facility - Athens, GA. A 4-week study of refrigerated storage facilities operated by the Agricultural Marketing Corporation, Kingston, Jamaica was conducted. This was part of a program carried out by the Agency for International Development to develop agriculture in the Carribean. A report was prepared and submitted to the Agricultural Marketing Corporation and the office of Rural Development, A.I.D., Kingston, Jamaica. The chairman of the AMC has stated that plans are underway to implement recommendations given in the report.

Cooling rate of sweet cherries and pears - Wenatchee, WA. Conclusions reached on sweet cherries were: (1) Auxiliary fans in cold rooms do not overcome the heat-retaining quality of tightly strapped unit loads in film liners, loosely stacked unit loads cooled faster; (2) cherries should be 32-36°F when packed; (3) cherries cooled 4 times faster in containers without liners; (4) containers without air vents required more carefully controlled air circulation in the storage room. Pears in film overwrapped trays cooled fastest, place pack fruit second, and pad-pack pears slowest.

Prototype apple bin filler constructed and tested - Wenatchee, WA. The tests showed that apples could be delivered to and released at the center of the filling chamber; that they could be accumulated to a depth representing one full bin; and that vertical gates could be lowered through the apple mass without unduly damaging the fruit. Further that the mass of apples could be removed from the chamber and released into a bin with very little bruising. Based on these findings fabrication of a full-scale commercial grade filler was initiated.

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This Annual Report was prepared by R. E. Hardenburg, Agricultural Marketing Research Institute, Beltsville, Maryland.

PUBLICATIONS

Albany, California

Kuhnle, J. A., G. Fuller, J. Corse, and B. E. Mackey. Antisenescent activity of natural cytokinins. *Physiol. Plantarum*. 41:14-21. 1977.

Fuller, G., J. A. Kuhnle, J. W. Corse, and B. E. Mackey. Use of natural cytokinins to extend the storage life of broccoli (*Brassica oleracea*, Italica Group). *J. Amer. Soc. Hort. Sci.* 192:480-484. 1977.

Platt, S. C. and J. A. Bassham. Separation of  $^{14}\text{C}$ -labeled glycolate pathway metabolites from higher plant photosynthate. *J. Chromatogr.* 133: 396-401. 1977.

Platt, S. G., Z. Plaut, and J. A. Bassham. Steady state photosynthesis in alfalfa leaflets: Effects of carbon dioxide concentration. *Plant Physiol.* 60: 230-234. 1977.

Platt, S. G., Z. Plaut, and J. A. Bassham. Ammonia regulation of carbon metabolism in photosynthesizing leaf discs. *Plant Physiol.* 60: 739-742. 1977.

Fresno, California

Buttery, R. G., D. G. Guadagni, L. C. Ling, R. M. Seifert and W. J. Lipton. Additional volatile compounds of cabbage, broccoli, and cauliflower. *J. Agr. Food Chem.* 24: 829-832. 1976.

Harvey, J. M. In-transit atmosphere modification--effects on quality of fruits and vegetables. *Proc. 2nd National Controlled Atmosphere Res. Conf.*, Mich. State Univ. Hort. Rept. No. 28: 71-78. 1977.

Hinsch, R. T., R. H. Hinds, and W. R. Goddard. Lettuce temperatures in a van container with a reverse airflow circulation. *U.S. Dept. Agr. Mktg. Res. Rept.* 1082. 4 pp. 1978.

Lipton, W. J. and J. M. Harvey. Compatibility of fruits and vegetables during transit in mixed loads. *U.S. Dept. Agr. Mktg. Res. Rept.* 1070. 7 pp. 1977.

Lipton, W. J. and J. M. Harvey. Compatibility of fruits and vegetables during transit in mixed loads. *Produce Mktg. Assoc. Produce Marketing Almanac.* 91, 93, 95, 97. 1977.

Lipton, W. J. Toward an explanation of disorders of vegetables induced by high  $\text{CO}_2$  or low  $\text{O}_2$ ? *Proc. Second Natl. Controlled Atmosphere Research Conf. Michigan State University.* 137-141. 1977.

Lipton, W. J. Recommendations for CA storage of broccoli, Brussels sprouts, cabbage, cauliflower, asparagus, and potatoes. *Proc. Second Natl. Controlled Atmosphere Research Conf. Michigan State Univ.* 277-281. 1977.

Lipton, W. J. Controlled atmospheres for fresh fruits and vegetables, p. 182-195. In: M. S. Peterson and A. H. Johnson (Eds.) Encyclopedia of Food Science. AVI Publ. Co., Westport, CT. 1978.

Lipton, W. J. Some bothersome market disorders of cantaloupes and other muskmelons. Proc. 29th International Conference on Handling Perishable Agricultural Commodities, Michigan State University. 105-109. 1977.

Rij, R. E. Performance of 35-pound fiberboard boxes jumble-packed with peaches and nectarines. U.S. Dept. Agr. Mktg. Res. Rpt. 1077. 7 pp. 1977.

Stewart, J. K. Factors influencing temperatures of produce during transport. Proc. 29th International Conference on Handling Perishable Agricultural Commodities, Michigan State University. p. 139-150. 1977.

#### Riverside, California

Houck, L. G. Problems of resistance to citrus fungicides. Proc. 3rd Int. Citrus Symp. 1: 263-269. 1977.

Norman, S. M., L. G. Houck, D. C. Fouse, J. W. Snider, P. F. Burkner, R. M. Perkins, and P. A. Nash. Changes in quality of field run dates under various combinations of outdoor and refrigerated storage. Date Growers' Inst. An. Rpt. 53: 9-17. 1976.

Norman, S. M. and D. C. Fouse. Application of near-infrared moisture analysis to dates. Date Growers' Inst. An. Rpt. 53: 18-20. 1977.

Norman, S. M. and D. C. Fouse. Changes in total aldehyde content with storage of Deglet Noor dates. Agric. and Food Chem. 25: 686-688. 1977.

Norman, S. M. and L. G. Houck. The role of volatiles in storage of citrus. Proc. 3rd Int. Citrus Symp. 1: 238-242. 1977.

#### Bradenton, Florida

Marousky, F. J. and B. K. Harbaugh. Influence of relative humidity on curing of caladium tubers. Proc. Fla. State Hort. Soc. 89: 284-287. 1976.

Harbaugh, B. K., G. J. Wilfret, A. W. Engelhard, W. E. Waters, and F. J. Marousky. Evaluation of 40 ornamental plants for 2 mass marketing systems utilizing sealed polyethylene packages. Proc. Fla. State Hort. Soc. 89: 320-323. 1976.

Miller, W. R., T. Moffitt, L. A. Risse, A. Bongors and F. J. Marousky. Importance of handling and shipping practices in exporting leatherleaf fern via van containers. Southern Florist and Nurseryman Magazine 90(1): 16, 17, 35-37. 1977.



Marousky, F. J. Controlled atmosphere and low pressure storage of gladiolus, chrysanthemums and snapdragons. In Controlled atmospheres for the storage and transport of perishable agricultural commodities. Michigan State University Hort. Rpt. No. 28: 116-121. 1977.

Marousky, F. J. Commodity requirements and recommendations for flowers and nursery stocks. In Controlled atmospheres for the storage and transport of perishable agricultural commodities. Michigan State Univ. Hort. Rpt. No. 28: p. 287. 1977.

Marousky, F. J. and S. S. Woltz. Influence of lime, nitrogen and phosphorus on the availability and relationship of soil fluoride to leaf scorch in Lilium longiflorum Thunb. J. Amer. Soc. Hort. Sci. 102(6): 799-804. 1977.

#### Gainesville, Florida

Gaffney, J. J. Engineering principles related to the design of systems for air cooling of fruits and vegetables in shipping containers. Proc. 29th International Conference on Handling Perishable Agricultural Commodities. pp. 151-164. Sept. 1977.

Gaffney, J. J. and C. D. Baird. Forced-air cooling of Bell peppers in bulk. Transactions of the ASAE 20(6): 1174-1179. 1977.

Gaffney, J. J., W. M. Miller and G. E. Coppock. Citrus fruit injury as related to mechanical harvesting with limb shaker-catch frame systems. Proc. Fla. State Hort. Society. 89: 179-182. May 1977.

Gaffney, J. J. and G. S. Birth. Detection of surface injuries on oranges by infrared reflectance. ASAE Paper 77-3022. June 26-29, 1977.

#### Miami, Florida

Spalding, D. H., R. J. Knight, Jr., and W. F. Reeder. Storage of avocado seeds. Proc. Fla. State Hort. Soc. 89: 257-258. 1976.

Spalding, D. H. Storage of avocados. In Proc. First Int. Trop. Fruit Short Course, Miami Beach, Florida. pp. 109-113. 1976.

von Windeguth, D. L., A. K. Burditt, Jr., and D. H. Spalding. Phosphine as a fumigant for grapefruit infested by Caribbean fruit fly. Fla. Entomol. 59: 285-286. 1976.

Spalding, D. H. and W. F. Reeder. Low pressure (hypobaric) storage of mangos. J. Amer. Soc. Hort. Sci. 102: 367-369. 1977.

Spalding, D. H. Low pressure (hypobaric) storage of avocados, limes, and mangos. In Controlled Atmospheres for the Storage and Transport of Perishable Agricultural Commodities, Mich. State Univ. Hort. Rept. 28: 156-164. 1977.

Spalding, D. H. Current recommendations of atmospheres for transport and storage of tropical fruit. In Controlled Atmospheres for the Storage and Transport of Perishable Agricultural Commodities, Mich. State Univ. Hort. Rept. 28: 242-249. 1977.

Orlando, Florida

Davis, Paul L., Kathleen A. Munroe and A. G. Selhime. Laboratory bioassay of volatile naturally occurring compounds against the Caribbean fruit fly. Proc. Fla. State Hort. Soc. 89: 174-175. 1976. Also in The Citrus Industry 58: 24-26. 1977.

Davis, Paul L. and Kathleen A. Munroe. Determination of biphenyl by gas and liquid chromatography. J. Agric. Food Chem. 25: 426-428. 1977.

Grierson, W. and T. T. Hatton. Factors involved in storage of citrus fruits: a new evaluation. 1977 Proc. Int. Soc. Citriculture. I: 227-231. 1977.

Hatton, T. T. and R. H. Cubbage. Effects of carbon dioxide and ethylene on stored 'Marsh' grapefruit. Proc. Natl. Controlled Atmosphere Res. Conf., Mich. State Univ. Hort. Rpt. 28: 189-196. 1977.

Hatton, T. T. and R. H. Cubbage. Status of controlled atmosphere storage research for citrus fruits. Proc. Natl. Controlled Atmosphere Res. Conf., Mich. State Univ. Hort. Rpt. 28: 250-259. 1977.

McCornack, A. A., G. E. Brown and J. J. Smoot. R23979, an experimental postharvest citrus fungicide with activity against benzimidazole-resistant penicilliums. Plant Dis. Repr. 61: 788-791. 1977.

McCoy, C. W., Paul L. Davis, and Kathleen A. Munroe. Effect of late season fruit injury by the citrus rust mite, Phyllocoptruta oleivora (Prostigmata:Eriophyoidea), on the internal quality of Valencia orange. Fla. Ent. 59: 335-342. 1976.

Smoot, John J. Factors affecting market diseases of Florida citrus fruits. 1977 Proc. Int. Soc. Citriculture. I: 250-254. 1977.

Athens, Georgia

Dekazos, E. D. Sclereid development and prevention of woodiness and/or grittiness in Rabbiteye blueberries. Fla. Sta. Hort. Soc. 90: 9-14. 1977.

Senter, S. D., W. R. Forbus, Jr., and C. J. B. Smit. Leucoanthocyanidin oxidation in pecan kernels: Relation to discoloration and kernel quality. J. Food Science. 43: 128. 1978.

Tyson, B. L. and W. R. Forbus, Jr. Experimental steam conditioner for inshell pecans. U.S. Dept. Agr., ARS-S-168. 7 pp. September 1977.

Byron, Georgia

Wells, J. M. Aflatoxin contamination in a sampling of southeastern pecans. Proc. Fla. Hort. Soc. 89: 256-257. 1977.

Wells, J. M. and R. J. Cole. Production of penitrem A and an unknown toxin by Penicillium lanosa-coeruleum isolated from weevil-damaged pecans. Phytopath. 67: 779-782. 1977.

Wells, J. M. Sour rot of peaches caused by Monilinia implicata and Geotrichum candidum. Phytopath 67: 404-408. 1977.

Chicago, Illinois

Beraha, L. Market diseases of muskmelons. Proc. 29th Int. Conference on Handling Perishable Agricultural Commodities. pp. 100-104. 1977.

Orono, Maine

Leach, S. S., R. E. Webb, and D. Wilson. Resistance to Fusarium tuber rot. Forty-seventh Annual Report of Cooperators of the Potato Breeding Program. U.S. Dept. Agr. (1976). pp. 94-96. 1977.

Beltsville, Maryland (Hort. Crops Marketing Laboratory)

Anderson, R. E., R. W. Penney, and W. L. Smith, Jr. Peach storage in a controlled atmosphere with intermittent warming: A pilot test using inexpensive flowmeters and plastic bags as CA chambers. HortScience. 12: 345-346. 1977.

Anderson, R. E., R. W. Penney, and W. L. Smith, Jr. Combining CA storage with intermittent warming extends the storage life of peaches and nectarines. Mich. State Univ., Hort. Rpt. No. 28: 149-155. 1977.

Anderson, R. E. and R. E. Hardenburg. Results and recommendations on controlled and modified atmosphere storage and transport of stone fruits. Mich. State Univ., Hort. Rpt. No. 28: 235-241. 1977.

Anderson, R. E. New innovations in cold storage of peaches. I. Temperature: Its role in cold storage. II. CA-IW: A new method of storing peaches. Proc. 6th Ann. South Carolina-Georgia Peach Convention. 1977.

Baker, J. E., C. Y. Wang, M. Lieberman, and R. E. Hardenburg. Delay of senescence in carnations by a rhizobitoxine analog and sodium benzoate. HortScience 12: 38-39. 1977.

Hardenburg, R. E., R. E. Anderson, and E. E. Finney. Quality and condition of 'Delicious' apples after storage at 0°C and display at warmer temperatures. J. Amer. Soc. Hort. Sci. 102(2): 210-214. 1977.

Hruschka, H. W. Postharvest weight loss and shrivel in five fruits and five vegetables. U.S. Dept. Agr., Mktg. Res. Rpt. 1059, 23 p. 1977.

Jen, J. J. and A. E. Watada. Red light advances respiration and ethylene evolution in ripening tomatoes. HortScience 12: 459-460. 1977.

Jen, J. J., K. H. Norris, and A. E. Watada. In vivo measurement of phytochrome in tomato fruit. Plant Physiol. 59: 628-629. 1977.



Moline, H. E. and H. W. Hruschka. Storage and handling of California Wonder sweet peppers (Capsicum annuum L.). *Acta Horticulturae* 62: 257-261. 1977.

Sapers, G. M., J. Abbott, D. Massie, A. E. Watada, and E. E. Finney, Jr. Volatile composition of McIntosh apple juice as a function of maturity and ripeness indices. *J. Food Science* 42: 44-47. 1977.

Wang, C. Y. Effect of aminoethoxy analog of rhizobitoxine and sodium benzoate on senescence of broccoli. *HortScience* 12: 54-56. 1977.

Wang, C. Y., J. E. Baker, R. E. Hardenburg, and M. Lieberman. Effect of two analogs of rhizobitoxine and sodium benzoate on senescence of snapdragons. *J. Amer. Soc. Hort. Sci.* 102: 517-520. 1977.

Wang, C. Y. and H. W. Hruschka. Quality maintenance in polyethylene-packaged broccoli. U.S. Dept. Agr., Mktg. Res. Rpt. 1085, 14 p. 1977.

Wang, C. Y. Effect of CO<sub>2</sub> treatment on storage and shelf life of sweet peppers. *J. Amer. Soc. Hort. Sci.* 102: 808-812. 1977.

Watada, A. E., J. A. Abbott, and E. E. Finney. Firmness of peaches measured nondestructively. *J. Amer. Soc. Hort. Sci.* 101(4): 404-406. 1976.

Watada, A. E., B. B. Aulenbach, and J. T. Worthington. Vitamins A and C in ripe tomatoes as affected by stage of ripeness at harvest and by supplemental ethylene. *J. of Food Science* 41: 856-858. 1976.

Watada, A. E. and K. H. Norris. Quality of fresh commodities estimated by spectrophotometric technique. In: *Encyclopedia of Food Science*, Martin S. Peterson and Arnold H. Johnson, editors, AVI Publishing Co., Inc., Westport, Conn. pp. 648-653. 1978.

Worthington, J. T., R. Day, and Barbara Aulenbach. A rapid, accurate, pictorial technique for continual assessment of tomato ripening behavior in commercial volume. *Acta Horticulturae* 62: 351-361. 1977.

Worthington, J. T., T. Van Der Zwet, and H. L. Keil. Reflectance and light transmittance techniques for measuring maturity and ripening of Eldorado and Bartlett pears. *Acta Horticulturae* 69: 327-333. 1977.

Beltsville, Maryland (Postharvest Plant Physiology Laboratory)

Banqui, S. M., A. K. Mattoo and V. V. Modi. Glyoxylate metabolism and fatty acid oxidation in mango fruit during development and ripening. *Phytochemistry*. 16: 51-54. 1977.

Chalutz, E. and M. Lieberman. Inhibition of ethylene production in Penicillium digitatum. *Plant Physiol.* 61: 111-114. 1978.

Chalutz, E., A. K. Mattoo, J. D. Anderson, and M. Lieberman. Regulation of ethylene production by phosphate in Penicillium digitatum. *Plant and Cell Physiol.* 19: 246-253. 1978.

Lieberman, M., J. E. Baker, and M. Sloger. Influence of plant hormones on ethylene production in apple, tomato and avocado slices during maturation and senescence. *Plant Physiol.* 60: 214-217. 1977.

Lieberman, M. and E. Knecht. Influence of ethylene on indole-3-acetic acid concentration in etiolated pea epicotyl tissue. *Plant Physiol.* 60: 475-477. 1977.

Mattoo, A. K. and M. Lieberman. Localization of the ethylene-synthesizing system in apple tissue. *Plant Physiol.* 60: 794-799. 1977.

Rao, M. N. and V. V. Modi. Fructose-1, 6-diphosphatase from mangifera indica. *Phytochemistry.* 15: 1437-1439. 1976.

Wang, C. Y., J. E. Baker, R. E. Hardenburg, and M. Lieberman. Effects of two analogs of rhizobitoxine and sodium benzoate on senescence of snapdragons. *J. Amer. Soc. Hort. Sci.* 102: 517-520. 1977.

Beltsville, Maryland (Seed Research Laboratory)

Abdul-Baki, A. and G. R. Chandra. Effects of rapid aging on nucleic acid and protein synthesis by soybean embryonic axes during germination. *Seed Science and Technol.* 5: 57-67. 1978.

Abdul-Baki, A. and Florence M. Cox. 1976-1977 Ann. Rpt. of the Organization for Economic Cooperation and Development (O.E.C.D.) Seed Schemes in the U.S.A. pp. 65. 1977.

Chandra, G. R. and A. Abdul-Baki. Separation of poly (A) RNA's synthesized by soybean embryos. *Plant and Cell Physiol.* 18: 271-275. 1977.

Chandra, G. R. and V. K. Toole. Release of esterase following germination of lettuce seed (Lactuca sativa L.). *Plant Physiol.* 59: 1055-1058. 1977.

Kulik, M. M. and E. J. Koch. A referee test of the blotter and guaiacol agar methods for the detection of Helminthosporium oryzae and Trichoconis padwickii in rice seeds. *J. Seed Technol.* 1: 71-78. 1976.

Kulik, M. M. Seed germinability tests for predicting field emergence of rice seeds infected with Helminthosporium oryzae and Trichoconis padwickii. *Phytopathology.* 67: 1303-1304. 1977.

Halfon-Meir, A. and M. M. Kulik. Septoria nodorum infection of wheat seeds produced in Pennsylvania. *Plant Disease Reporter.* 61: 867-869. 1977.

Toole, V. K. and E. J. Koch. Light and temperature controls of dormancy and germination in bentgrass seeds. *Crop Science.* 17: 806-811. 1977.

Velasco, J. and G. R. Chandra. Determination of abscisic acid as p-nitrobenzyl ester. *Plant Physiol.* 59: 76. 1977.

VanDerWoude, W. J. The plasma membrane-cell wall interface: Freeze-fracture studies of pea seedlings. Plant Physiol. 59 (suppl): 26. 1977.

Woodstock, L. W. and V. K. Toole. Respiration of Grand Rapids lettuce (*Lactuca sativa* L.) seeds in relation to chemical and photocontrol of germination. Plant & Cell Physiol. 18: 1-8. 1976.

Woodstock, L. W., J. Simkin and E. Schroeder. Freeze-drying to improve seed storability. Seed Sci. and Technol. 3: 301-311. 1976.

#### East Lansing, Michigan

Burton, C. L., B. R. Tennes and G. K. Brown. Forced-air cooling of apples in bulk storage--a progress report. ASAE Paper 77-6512. American Society of Agricultural Engineers, St. Joseph, MI. 1977.

Tennes, B. R., C. L. Burton and R. F. Carlson. How close are we to an over-the-row integrated spraying, pruning, and harvesting system. Compact Fruit Tree. 10: 114-116. 1977.

Tennes, B. R. and C. L. Burton. A progress report on the mechanization of hedgerow and high-density orchard cultures. ASAE Paper No. 77-1033. 1977.

Tennes, B. R. and C. L. Burton. Metering and spray apparatus for horticultural application. U.S. Patent Serial # 4,030,244. 1977.

Tennes, B. R. and C. L. Burton. Continuous mechanized harvesting of horticultural crops. U.S. Patent Serial # 4,064,683. 1977.

#### East Grand Forks, Minnesota

Hudson, D. E. and P. H. Orr. Incidence of mechanical injury to potatoes during certain storage-related handling operations in the Red River Valley production Area. Amer. Potato J. 54: 11-21. 1977.

Yaeger, E. C. and G. L. Pratt. Instrumentation for measurement of lateral and vertical pressures in potato storages. Trans. Amer. Soc. Agr. Engr. 20: 6, 1180-1184. 1977.

Yaeger, E. C. Weight loss and pressure flattening of stored potatoes. Paper No. 77-4061, Amer. Soc. Agr. Engr., St. Joseph, MI. 1977.

Yaeger, E. C. and L. A. Schaper. Lateral and vertical pressures on potato storage structures. Paper No. NCR 77-1016, Amer. Soc. Agr. Engr., St. Joseph, MI. 1977.

Yaeger, E. C. and L. A. Schaper. Lateral and vertical pressures on potato storage structures. Paper No. NCR 77-1016, Amer. Soc. Agr. Engr., North Central Region and Canadian Soc. Agr. Engineering Manitoba Region Ann. Meeting. 1977.



New Brunswick, New Jersey

Cappellini, R. A. and M. J. Ceponis. Vulnerability of stem-end scars of blueberry fruits to postharvest decays. Phytopathology. 67: 118-119. 1977.

Ceponis, M. J. Postharvest disease control. Amer. Veg. Grower. 25: 23-24. 1977.

Hudson, D. E. and P. H. Orr. Incidence of mechanical injury to potatoes during certain storage-related handling operations in the Red River Valley production area. Amer. Potato J. 54(1): 11-12. 1977.

ANNUAL REPORT  
FY 1977

National Research Program 20590

TECHNOLOGIES FOR MARKETING FIELD CROPS

This ARS National Research Program involves basic and applied research concerned with the measurement, improvement, maintenance and protection of the quality of field crops. It is concerned with the physical distribution costs of marketing farm and food products from farm to consumer. It develops improved handling methods, equipment, operating procedures and facilities to increase their efficiency and effectiveness, increase labor productivity, reduce marketing costs and conserve energy. The functions to which these physical elements relate are assembling, conditioning, preparing for market, sorting, grading, processing, loading, transporting, unloading, storing, warehousing, wholesale and retail distribution.

NPS Contact: (D. L. Anderson, Interim)

PACS Contact: C. Golumbic

Technological Objective 1:

Develop new and improved technologies for maintaining product quality and reducing losses in the marketing channels.

Research Locations:

Dawson, Georgia  
Peoria, Illinois  
West Lafayette, Indiana  
Manhattan, Kansas  
Beltsville, Maryland  
Raleigh, North Carolina

Selected Examples of Recent Progress:

Freshness and flavor protected by carbon dioxide packaging - Dawson, GA. Results from the carbon dioxide sorption packaging method have shown that freshness and flavor is protected to one year on raw and roasted peanuts. On pecans, the freshness and flavor were protected up to 6 months, but even after 12 months, only slight deterioration of the flavor and freshness was noticeable.

Vacuum-packaging cheaper and saves energy - Dawson, GA. Results from the second year of the vacuum packaging study showed that it was cheaper and required considerably less energy than the refrigerated storage. Those samples which were back-flushed with nitrogen after an initial vacuum of 24 inches were superior in germination to the controls and other treatments.

Heredity and area of growth has effect on protein composition - Dawson, GA. Protein analyses on the samples from the National-Regional Variety Trials showed that the area of growth as well as heredity had a significant effect on protein composition of peanuts.

New drying method reduces electrical demand and energy consumption - Dawson, GA. By cutting off dryers periodically with a simple timing device, dryer operation can be reduced by as much as one-third with no significant effect on the drying process. Electrical demand for a drying facility can be lowered by one-third and total drying costs by \$2.60 per trailer for drying 20 percent moisture content peanuts.

Device to detect peanuts of low market value - Dawson, GA. Scientists at the National Peanut Research Laboratory were requested by the Research and Development Committee of the Southeastern Peanut Association to develop a device that would detect peanuts of low market value which resulted from poor drying practices. A meter was developed to print out the moisture content profile of the individual kernels of a peanut sample and shows promise.

Design of commercial-type peanut shellers improved - Dawson, GA. The design of commercial-type shellers using cast iron and T-bar grates was further improved to provide a maximum outturn. Major improvements consisted of optimizing the design of surge hopper and sheller grates. Over 50 percent of the peanuts grown in the U.S. are shelled by these particular types of shellers. These improvements should benefit the industry by at least \$1 million annually.

Energy-saving drying method for corn - Peoria, IL. Spoilage is suppressed during ambient air drying of high-moisture corn by adding small amounts of ammonia or sulfur dioxide intermittently into a stream of ambient air being blown through corn. This "trickle process" is flexible, economic, saves energy, and extends the time to safely dry corn with ambient air. The process will function over a wide range of weather conditions and offers the farmer corn free of molds and toxins, with excellent physical and nutritional characteristics.

#### Technological Objective 2:

Develop and evaluate techniques of quality measurements for improvement of grades, standards, and as a basis for consumer protection.

#### Research Locations:

Dawson, Georgia  
Manhattan, Kansas  
Beltsville, Maryland  
Raleigh, North Carolina



Selected Examples of Recent Progress:

Methanolic extraction method can predict date to dig peanuts - Dawson, GA. Three years of testing the methanolic extraction method for estimating the maturity in peanuts has shown that the method can predict the date to dig peanuts for the greatest dollar return per acre for optimum quality.

Method for determining protein in hard red winter wheat adopted by Federal Grain Inspection Service - Manhattan, KS. The work reported in an article entitled "Inter- and Intra-Laboratory Reproducibility of Protein Determination in Hard Red Winter Wheat by Kjeldahl and Near Infrared Procedures," was the basis for the decision made by the Federal Grain Inspection Service to use near infrared instruments to measure protein in hard red winter wheat for export and for voluntary federal protein testing effective May 1, 1978.

Determination of sprout-damaged wheat in marketing channels - Manhattan, KS. A simple, rapid, and sensitive colorimetric method to determine  $\alpha$ -amylase as an index of sprout-damaged wheat was developed. The method has been adopted for use in a compact, self-contained unit for measuring  $\alpha$ -amylase in agricultural products in field conditions. Thus, sprout damaged wheat can be identified as it occurs in the field.

Microscopic controls for breadmaking - Manhattan, KS. An in-depth light and transmission microscopic study has demonstrated the effects of mixing requirements and mixing tolerance of flours on quality of bread baked from flours that differ in breadmaking quality. The interaction between starch and protein fibrils in production of acceptable bread-crumbs structure was demonstrated.

Simple correlations between emergence and stand were high and significant - Beltsville, MD. This would indicate that in the evaluation of germplasm or seed lots for emergence potential, one planting at one location would be sufficient, saving time and research investment.

Three vigor tests will estimate 80% of the variability observed in the field - Beltsville, MD. This was determined by statistical analysis of the lab variables. The analysis indicated that several combinations of three vigor tests will predict approximately the same quantity of variability observed in the field. This should minimize field testing time considerably.

Technological Objective 3:

Reduce costs in distribution and marketing systems by increasing physical efficiency, reducing energy requirements and improving work methods.

Research Locations:

West Lafayette, Indiana

Ames, Iowa

Manhattan, Kansas

Raleigh, North Carolina

Beaumont, Texas

Selected Examples of Recent Progress:

Harvesting and drying wheat for profit and quality - West Lafayette, IN.  
Management considerations concerning the use of existing equipment and facilities for harvesting and drying high-moisture wheat using solar heated, unheated or fossil-fuel heated in-bin drying systems which allows 7, or more, days earlier planting of a second (double) crop of soybeans have been determined. Each day of earlier planting in the mid-Midwest means from 0.5 to 1.0 bu/a increase in soybean yield, with 1.5 days increase needed to recover costs.

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This Annual Report was prepared by Yeshajahu Pomeranz, U.S. Grain Marketing Research Laboratory, Manhattan, Kansas.

PUBLICATIONS

Dawson, Georgia

Blankenship, P. D. and E. J. Williams. Air flotation velocities and physical properties of peanuts and foreign materials. Peanut Science 4: 57-62. 1977.

Sanders, T. H. Changes in tannin-like compounds of peanut fruit parts during maturation. Peanut Science 4:51-53. 1977.

Peoria, Illinois

Bothast, R. J., L. T. Black, L. L. Wilson, and E. E. Hatfield. Methylene-bis-propionate (MBP) preservation of high moisture corn. J. Animal Sci. 46. 1978.

Bothast, R. J. and K. L. Smiley. Metabolites of fungi used in food processing. In Food and Beverage Mycology, Chapter 13, L. R. Beuchat ed. The AVI Publishing Company, Inc., Westport, Connecticut. 1977.

Bothast, R. J., L. R. Beuchat, B. S. Emswiler, M. G. Johnson, and M. D. Pierson. Incidence of airborne Aspergillus flavus spores in cornfields of five states. Appl. Environ. Microbiol. 35. 1978.

Fennell, D. I., W. F. Kwolek, E. B. Lillehoj, G. L. Adams, R. J. Bothast, M. S. Zuber, O. H. Calvert, W. D. Guthrie, A. J. Bockholt, A. Manwiller, and M. D. Jellum. Aspergillus flavus presence in silks and insects from developing mature corn ears. Cereal Chem. 54:770-778. 1977.

Hesseltine, C. W. and R. J. Bothast. Mold development in ears of corn from tasseling to harvest. Mycologia 69:328-340. 1977.

Hesseltine, C. W., R. F. Rogers, and R. J. Bothast. A Microbiological study of exported soybeans. Cereal Chem. 55. 1978.

Nofsinger, G. W., R. J. Bothast, E. B. Lancaster, and E. B. Bagley. Ammonia-supplemented ambient temperature drying of high-moisture corn. Trans. ASAE 20:1151-1154, 1159. 1977.

West Lafayette, Indiana

Anderson, M. E. and C. J. Bern. Low-temperature corn drying with a solar-assisted heat pump. ASAE Paper #77-3010, presented at ASAE Annual Meeting, Raleigh, N.C., June 27-29, 1977.

Baker, J. L. and G. C. Shove. Solar grain drying in Illinois. ASAE Paper #77-3009. 1977.

Barrett, J. R., Jr. and J. B. Stevens. Solar drying of wheat. Proc. Solar Grain Drying Conference, pp. 255-6, Univ. of Illinois, Urbana-Champaign, Illinois. 1977.



Calderwood, D. Rice drying with solar heat. ASAE Paper #77-3003, presented at ASAE Annual Meeting, Raleigh, N.C., June 27-29, 1977.

Chau, K. V., C. D. Baird and L. O. Bagnall. Performance of a plastic solar air heater. ASAE Paper #77-4014. 1977.

Converse, H. H., G. H. Foster, H. K. Koh. Storing solar heat for drying grain. ASAE Paper #77-3008, presented at ASAE Annual Meeting, Raleigh, N.C., June 27-29, 1977.

Eckhoff, S. R., M. R. Okos, R. M. Peart and A. F. Badenhop. Solar energy storage mediums. ASAE Paper #76-3513, St. Joseph, Mi. 1976.

Hellickson, M. A., W. H. Peterson, S. E. Saienga and J. L. Julson. Performance of a solar energy-intensifier with thermal energy storage. ASAE Paper #77-4533, St. Joseph, Mi. 1977.

Julson, J. L., M. A. Hellickson and W. H. Peterson. Space heating with a solar energy-intensifier-thermal energy storage system. ASAE Paper No. NCR 77-1006, ASAE, St. Joseph, Mi. 1977.

Keener, H. M. Energy management in corn drying. The Ohio Farmer 260(4):12-13. September 3, 1977.

Kline, G. L. Solar collectors for low-temperature grain drying. ASAE Paper #77-3007, presented at ASAE Annual Meeting, Raleigh, N.C., June 27-29, 1977.

Koh, H. K. Study of the use of solar energy for regeneration of silica gel used for grain drying. (Ph.D. Thesis), Kansas St. University. 1977.

No, S. H., D. B. Brooker, and M. K. Misra. Heat storage in a low melting temperature eutectic. ASAE Paper #77-4538, presented at ASAE Winter Meeting, Chicago, Illinois. December 13-16, 1977.

Parker, B. F. Multiple fin solar energy receiver for line focusing collectors. ASAE Paper #77-4534, presented at ASAE Winter Meeting, Chicago, Illinois, December 13-16, 1977.

Sabbah, M. A., H. M. Keener, G. E. Meyer. Simulation of solar grain drying using the logarithmic model. ASAE Paper #77-3012, presented at ASAE Meeting, St. Joseph, Mi. June 1977.

Saienga, S. E., M. A. Hellickson and W. H. Peterson. Crop drying with a solar energy-intensifier. ASAE Paper No. NCR 77-1005, ASAE, St. Joseph, Michigan. 1977.

Shove, G. C. Drying grain with solar energy. Illinois Research 19(2): 5-6. Spring 1977.

Smit, C. D. and G. C. Shove. Covered plate solar collector incorporated into wall and roof of a farm building. ASAE Paper #76-3515 1977.

Turner, L. W., A. C. Dale and B. A. McKenzie. Solar heating for home, farm and small business. AE-88 Cooperative Extension Service, Purdue University, W. Lafayette, Indiana. 1977.

Williams, E. E., M. R. Okos, R. M. Peart and A. F. Badenhop. Solar grain drying and collector evaluation. ASAE Paper #76-3512, St. Joseph, Mi. 1976.

Williams, E. E., R. M. Peart, J. R. Barrett, Jr., and G. H. Foster. Solar grain drying. AED-128, Dept. of Agr. Eng., Purdue Univ. W. Lafayette, Ind. 1977.

#### Manhattan, Kansas

Aldis, D. F. and G. H. Foster. Moisture changes in grain from exposure to ambient air. ASAE Paper #77-3524. ASAE Winter Meeting, Chicago, Il. 1977.

Bechtel, D. B. and Y. Pomeranz. Ultrastructure of the mature ungerminated rice (*Oryza sativa*) caryopsis. The caryopsis coat and the aleurone cells. Amer. Jour. of Botany 64:966-973. 1977.

Chung, O. K. and Y. Pomeranz. Wheat flour lipids, shortening, and surfactants--A three-way contribution to breadmaking. Baker's Digest 51(5):32-34, 36-38, 40, 42-44, 151. 1977.

Chung, O. K., Y. Pomeranz, K. F. Finney and others. Defatted and reconstituted wheat flours I. Effect of solvent and Soxhlet types on functional (breadmaking) properties. Cereal Chemistry 54:454-465. 1977.

Chung, O. K., Y. Pomeranz, K. F. Finney and M. D. Shogren. Defatted and reconstituted wheat flours II. Effects of solvent type and extracting conditions on flours varying in breadmaking quality. Cereal Chemistry 54:484-495. 1977.

Converse, H. H. and G. H. Foster. Storing solar heat for drying grain. ASAE Paper #77-3008, ASAE Summer Meeting, Raleigh, N.C. 1977.

Dikeman, E. and Y. Pomeranz. Note on mineral contents of dark hard and yellow hard kernels separated from red winter wheat. Cereal Chemistry 45:183-186.

Finney, K. F., Y. Pomeranz, L. C. Bolte, and M. D. Shogren. High yielding European wheats: Determination of end-use properties. Baker's Digest 51(1):28-30, 32-34, 36.

Finney, K. F., Y. Pomeranz, L. C. Bolte, and M. D. Shogren. Hohertragreiche europäische Weizensorten. Beurteilung des Verwertungswertes. Getreide Mehl und Brot 31:57-63. 1977.

Greenaway, W. T., C. A. Watson, and G. D. David. Factors for converting bushel weight to hectoliter weight for six cereal grains, flax and soybeans. Cereal Chemistry 54:373-378. 1977.

Heid, W. G., Jr. The performance and economic feasibility of solar grain drying systems. Ag. Ec. Report No. 396, USDA. 1978.

Hubbard, J. D., Y. Pomeranz and F. S. Lai. Note on protein contents and amino acid composition of dark hard and yellow hard kernels separated from red winter wheat. Cereal Chemistry 54:778-783. 1977.

Lai, F. S. and L. T. Fan. Application of pattern recognition techniques to solids mixing--feature extraction. Computer & Chemical Eng. 1:171-181. 1977.

Martin, C. R. and L. E. Stephens. Broken corn and dust generated during repeated handling Trans. ASAE 20(1):168-171. 1977.

Mathewson, P. R. and Y. Pomeranz. Detection of sprouted wheat by a rapid colorimetric determination of  $\alpha$ -amylase. Jour. of the Assoc. of Official Analytical Chemists 60:16-20. 1977.

McGinty, R. J., C. A. Watson, R. Rousser, and others. Note on modification of the Udy-modified Weber mill. Cereal Chemistry 54:187-189. 1977.

Pomeranz, Y. Fiber in breadmaking--A review of recent studies. Baker's Digest 51(5):94-96, 142. 1977.

Pomeranz, Y. Theorie und praxis der bestimmung unterschiedlichen einflusses einzelner weizenkomponenten auf das backverhalten. Getreide Mehl und Brot 31:147-152. 1977.

Pomeranz, Y., R. B. Moore and F. S. Lai. Reliability of five methods for protein determination in barley and malt. Jour. of the Amer. Soc. of Barley Chemists 35(2):86-93. 1977.

Pomeranz, Y., M. D. Shogren, and K. F. Finney. Flour from germinated soybeans in high-protein bread. Jour. of Food Sci. 42:824-842. 1977.

Pomeranz, Y., Shogren, M. D., Finney, K. F. and Bechtel, D. B. Fiber in breadmaking--effects on functional properties. Cereal Chem. 54:24-41. 1977.

Sauer, D. B. Contamination by mycotoxins: When it occurs and how to prevent it. In T. O. Wyllie and L. G. Morehouse, ed. Mycotoxic Fungi, Mycotoxins, Mycotoxicoses: An Encyclopedic Handbook, Vol. 3. Marcel Dekker, Inc., New York. 1978.

Stermer, R. A., Y. Pomeranz, and R. J. McGinty. Infrared reflectance spectroscopy for estimation of moisture of whole grain. Cereal Chemistry 54:345-351. 1977.

Stermer, R. A., C. A. Watson and E. Dikeman. Infrared spectra of milled rice. Trans. ASAE 20(3):547-549, 557. 1977.

Watson, C. A. and E. Dikeman. Structure of the rice grain shown by scanning electron microscopy. Cereal Chemistry 54:120-130. 1977.

Watson, C. A. and E. G. Heyne. Individual kernel weight distribution of 12 varieties of hard red winter wheat. Cereal Chemistry 54:161-166. 1977



Beltsville, Maryland

Anderson, J. D. Adenylate metabolism of embryonic axes from deteriorated soybean seeds. *Plant Physiol.* 59:610-614. 1977.

Anderson, J. D. Responses of adenine nucleotides in germinating soybean embryonic axes to exogenously applied adenine and adenosine. *Plant Physiol.* 60:689-692. 1977.

Nicholas, C. J. and M. E. Whitten. Do soybeans deteriorate during shipment? *Soybean Industry Digest*, pp. 18a-18d. February 1978.

Yaklich, R. W. and M. D. Orzolek. Effect of polyethylene glycol-6000 on pepper seed. *Hortscience* 12(3):263-264. 1977.

Raleigh, North Carolina

Nelson, M. S., H. E. Pattee and J. A. Singleton. Calcium activation of peanut lipooxygenase. *Lipids* 12:418-422. 1977.

Pattee, H. E. and J. A. Singleton. Isolation of positional and geometrical isomers of hydroperoxides and the evaluation of the effects of selected parameters on their ratio. *Ann. Technol. Agric. de l INRA.* June 14, 1977.

Pattee, H. E., J. C. Wynne, J. H. Young and F. R. Cox. The seed-hull weight ratio as an index of peanut maturity. *Peanut Science* 4:47-50. 1977.

Pattee, H. E. and J. A. Singleton. Isolation of Isomeric hydroperoxides from the peanut lipooxygenase-linoleic acid reaction. *JAOCs* 54:183-185. 1977.

Singleton, J. A. and H. E. Pattee. Headspace techniques used in the analysis of volatile components from lipooxygenase catalyzed reactions. In *Analysis of Food and Beverages - Headspace Techniques*, G. Charalambous ed. Academic Press, New York, N.Y. November 2, 1977.

NRP ANNUAL REPORT  
FY 1977

National Research Program 20600

TECHNOLOGIES AND FACILITIES FOR MARKETING LIVESTOCK AND ANIMAL PRODUCERS

This ARS-NRP is one of four dealing with marketing efficiency under the Department's Program No. 617: "Marketing Efficiency Research." It covers livestock, poultry, and animal and poultry products. The overall USDA mission relates to agricultural marketing efficiency and the operating goal is research for new products and processes and for reducing marketing costs.

NPS Contact: D. L. Anderson

PACS Contact: C. Golumbic

Technological Objective 1:

Develop new and improved technologies for maintaining product quality and reducing losses in the marketing channels.

Research Locations:

Beltsville, Maryland  
College Station, Texas  
Columbia, Missouri

Selected Examples of Recent Progress:

The determination of species of origin in meat products - Beltsville, MD. Antisera to sera of pig, horse, and rabbit were used in agar gel diffusion reactions to determine the presence of flesh from these species in fresh ground beef. The results indicated that each antiserum to species serum (a) did not react with bovine serum, (b) reacted with normal species serum, and (c) reacted with extracts of ground beef adulterated at 1, 3, and 5% levels with flesh from each species.

The agar-gel precipitin reaction of Oudin was modified to demonstrate the presence of albumins from both pig and rabbit serum in extracts of ground beef adulterated collectively with 10% flesh from these species. Replacement of the combined antigen layers with isolated species albumin after one day of band development produced changes in individual band migration rates which could be used to positively identify both species in doubly adulterated products.

The effects of postmortem electrical stimulation, hot boning, and storage temperature on rate of pH decline and muscle color was investigated. - Beltsville, MD. Electrical shock significantly increased the rate of pH decline while hot boning excision significantly affected color uniformity of the semimembranosus muscle.

Sixty calf carcasses were either electrically shocked postmortem or received no shock and were either hot or cold skinned. The objective of the study was to evaluate the effect of electric shock on hot or cold skinned calf carcasses. Electrically shocked carcasses were more tender than nonshocked carcasses while hot skinned carcasses were slightly more tender than those cold skinned.

Research on ground beef is underway - Beltsville, MD. The effect of precooking beef patties on palatability and shelf life was investigated. Patties that were precooked, frozen, and reheated were significantly tougher and drier than nonprecooked patties. There seems to be little advantage to precooking beef patties.

Chlorine as a bactericide on meat - Beltsville, MD. Fourteen pure and mixed bacterial cultures were exposed to varying concentrations of aqueous chlorine on Tryptone glucose agar. The organic components of the agar partially neutralized the chlorine so that the germicidal effect of chlorine was diminished substantially. In the presence of the organic compounds of the agar, chlorine at 200 ppm did not destroy any of the four serotypes of Salmonella tested. Psychrotropic bacteria were more susceptible to destruction by the aqueous chlorine than were the mesophilic bacteria.

Rats were fed, for 30 days, meat that was treated with aqueous chlorine to ensure that the feeding regime did not have any adverse effect. The FDA wanted assurances about the diet before the longer study involving histological examination of tissues from sacrificed rats was carried out.

Determine contributing causes of bruising, crippling, death, and condemnation of cattle attributable to livestock transport equipment - College Station, TX. During September and October, 1977, two paired (two livestock tractor, semi-trailer units) experimental shipments were made. A total of 373 head of cattle were shipped in these four loads. Observations were made during time of loading at Algood, TN and at time of unloading at Bushland, TX. The animals were loaded and unloaded for the September shipment without incident and all animals walked off the trucks. Loading began in Algood, TN for the second shipment at 0630, October 28, 1977. Lighting was poor over the loading ramp and dark inside the livestock trailer. On entering the vehicle some animals fell and were run over by following cattle. The animals were confused and handlers used "hot shots" to get them into their assigned compartments. On arrival at destination all of the animals walked off but if these had been slaughter animals there would have been bruised tissue which would have been cut away during the dressing process. Much of the apparent injury could have been prevented by having the ramps and transport vehicle well lighted, less steeply inclined ramps, and more orderly handling of the animals from pens to the ramp and into the vehicle.



Determine the effect of acceleration, deceleration, vertical vibration, as well as, the side to side motion of the transport vehicle to the animals health - College Station, TX. Equipment used (Impact-O-Graph) to measure and record this data proved to be unreliable. When working, it gave only the gross measurement for the event, more frequently it would jam and would not record. We have purchased a Bruel and Kjaer (B&K) portable triaxial accelerometer and a 4 channel, FM recorder which are reported to be more accurate and reliable than the previously used instrument. We received this equipment too late to be used on any of our experimental shipments this report year.

Determine the presence and concentrations of noxious fumes, from the transport vehicle (tractor) and other highway conditions within the livestock trailer, to immediate and latent effects on animal health - College Station, TX. We have not, as yet, located any portable equipment to measure the various gas concentrations in a livestock trailer. We have requested proposals for a device(s) to sample, measure and record carbon monoxide (CO), hydrogen sulfide ( $H_2S$ ), nitric oxide (NO), nitrogen oxide ( $NO_2$ ), and total hydrocarbons.

Develop methods and equipment for reducing and keeping to a low level the number of microorganisms on beef carcasses - Columbia, MO. Plate meat was washed and/or sanitized with cold water, hot water, steam, sodium hypochlorite, or acetic acid before being stored up to 28 days at  $3.3^{\circ}C$  and 90% relative humidity. Microbial counts made initially and weekly thereafter disclosed that, compared with untreated controls, time to reach counts of  $10^8$  bacteria per  $cm^2$  were: (1) 1 day less with steam or water-treated samples; (2) 2-3 days more with hypochlorite-treated samples; (3) 5 days more with hot water-treated samples, and (4) 23-24 days more with acetic acid-treated samples. Resanitization with acetic acid extended time to reach counts of  $10^8$   $cm^2$  by 7 more days.

Forty-eight half carcasses from a stressed meat study were washed or washed and sanitized (3.0% acetic acid), using a prototype carcass cleaning and sanitizing unit, to determine the effect of the treatment on the water uptake, shrinkage (24 hours after slaughter), foreign material (hair), microbial populations, pH and acidity of the surface of the meat. The conditions of water and sanitizer application were 290 liters/minute at a pressure of 26.4 kilograms/ $cm^2$  and 94.6 liters/minute at 14.1 kilograms/ $cm^2$ , respectively. The mean water uptake for 24 carcasses, washed but not sanitized, was 0.45 kilograms with a standard error of the mean of 0.12 kilograms. Shrinkage after 24 hours (compared to initial carcass weight) was 1.686 kilograms. For carcasses washed and sanitized, initial shrinkage was 0.739 kilograms with the standard error of the mean being 0.106 kilograms. The probability of a significant difference in the water uptake between the two treatments was 8.07%. No difference in shrinkage was observed between the two treatments. The pH of the meat surface was reduced by 0.43 units (5.69 to 5.25) by sanitization with 3% acetic acid solution. After 24 hours in the cooler, the pH

of the surface had risen by 0.13 units. The pH of the meat surface subjected to only a water treatment was not significantly changed during storage. Titratable acidity of the surface was increased by 0.03% acetic acid as a result of sanitizing. After 24 hours the titratable acidity had dropped by 0.01% acetic acid. The wash treatment caused no change in titratable acidity of the meat. However, after 24 hours the acidity had decreased slightly.

Aerobic plate counts were reduced 1.66 logs by washing and sanitizing with only a reduction of 0.17 logs by washing. After 24 hours, the reduction for washing and sanitizing was 1.29 logs and that for washing was 0.37. After one week, the reduction was 0.16 log for washing and sanitizing, but there was an increase of 0.76 logs for carcasses which were only washed. Tests for Acceptable Quality Level (Federal inspection procedure) revealed only minor discrepancies.

#### Technological Objective 2:

Develop new and improved techniques of quality measurements for use in grading, standardization and inspection programs and as a base for consumer protection.

#### Research Locations:

Athens, Georgia  
Beltsville, Maryland

#### Selected Examples of Recent Progress:

Evaluate the Enterobacteriaceae count as an index of the sanitary quality of poultry during processing - Athens, GA. Enterobacteriaceae counts and the salmonella status (positive or negative) of 20 individual birds in each of 12 groups of broiler carcasses obtained at the processing plant and retail level were determined. The overall logarithmic mean Enterobacteriaceae count for the 240 carcasses was 2.7 with group means ranging from 1.8 to 3.6. One hundred and twenty-three (51.2%) of the 240 carcasses were positive for salmonella. The number of salmonellae positive carcasses within groups ranged from 0 to 18. No relationship was found between Enterobacteriaceae counts and the presence of salmonella in broiler carcasses.

Develop new and improved techniques of quality measurements for use in grading, standardization, and inspection programs and as a base for consumer protection - Beltsville, MD. A flavor profile panel evaluated steaks from 33 beef loins differing widely in marbling, maturity and previous flavor acceptability panel ratings. Low relationships were found between flavor profile panel descriptions and carcass, chemical and cooking traits. Steaks from 132 calf and beef carcasses were evaluated for palatability differences by trained sensory panels from two institutions. Calf muscle was significantly more tender than beef (A-). The beef carcasses were more flavorful and juicy than calf.

Data from 1,000 beef loins and four institutions are presently being analyzed. The results will be utilized to evaluate the present beef quality grades . Sensory panel techniques were developed for use in this study. These techniques have been adopted by the American Meat Science Association as standard methods for meat scientists.

A total of 938 yearling steers have been selected to represent all combinations of frame and muscling score. The cattle were assigned to one of three feeding periods. The study is at its midpoint. The results will be used to evaluate the proposed USDA feeder cattle grades.

Loin steaks from 78 carcasses were categorized into three tenderness groups on the basis of sensory tenderness ratings. Myofibril fragmentation index (MFI), sarcomere length, total and soluble collagen, moisture, fat and pH values were determined for these steaks. Results show that MFI accounted for over 50% of the variation on tenderness.

A method for acceptically excising a meat microbiological sample was developed to improve the accuracy of surface sampling - Beltsville, MD. Measurement of coliform, aerobic bacteria, molds and yeasts in the air of a commercial pig slaughter and processing plant was completed using a Ross air sampler. Data were obtained to characterize (a) seasonal variations and (b) product processing operations.

#### Technological Objective 3:

Reduce costs in distribution and marketing systems by increasing physical efficiency, reducing energy requirements, and improving work methods.

#### Research Locations:

Athens, Georgia  
Beltsville, Maryland  
College Station, Texas

#### Selected Examples of Recent Progress:

Improve the efficiency of restraining, assembling, transporting, holding and receiving dock handling of live broilers - Athens, GA. A device was developed to invert the transport coops to the upright position after they were emptied of their load of chickens by the mechanical live bird handling system previously developed. The coops are then easily and quickly restacked for transport back to the growout houses to obtain another load of live poultry.

Starting chickens in battery (cage) brooders in separate, environmentally controlled facilities, then transferring to floor growout at 3 weeks of age, was tested experimentally. Growth rate, feed conversion and mortality rate compared favorably to standard all-floor starting growout.



Bird transfer concepts which had been developed for the processing plant live bird unloading system were applied to the transfer operation from battery brooder to floor facility.

Feasibility of an on-the-farm milk processing plant shown - Beltsville, MD. Layouts and improved operating methods were developed for a new on-the-farm milk processing plant to be built in conjunction with production operations, as an alternative to dairy farmers for increasing the returns on their production of a 200 cow herd rather than selling it through normal channels, the annual farm income is increased by 26 percent. The construction of on-the-farm processing plants is important to local economies because it creates additional employment opportunities and provides a source of products for the small volume retail outlets that cannot be efficiently served by the larger processors.

Improved layouts and operating methods for a dairy processing plant - Beltsville, MD. Since the facilities and operating methods used in processing and handling dairy products largely determine the cost of these products to the consumer, a large dairy products processing plant was studied to determine the impact improvements have on production labor cost. Research findings showed that by remodeling the existing plant to handle a 50-percent increase in present volume, the production labor cost is reduced by 26.6 percent annually, as compared to 37.0 percent in new facilities. Because of the extremely large number of older plants now operating in the United States, which are typical of the one studied, it is estimated that over 50 percent will benefit directly from the research and achieve a savings in excess of \$100 million annually.

Broiler and Turkey Grading Study Released - Beltsville, MD. Federal Research scientists along with representatives of FSQS gathered and analyzed data from 18 processing plants on the accuracy and efficiency of grading broilers and turkeys. Grading in these plants is performed under the supervision of a USDA licensed resident grader. Three broiler and three turkey plants were selected as representative examples of the types of acceptable grading methods and facilities used extensively in the poultry industry. Grading facilities in each plant were described and illustrated in a report being published, along with factors that influence accuracy and efficiency. FSQS representatives plan to utilize the publication to show processors how to improve their grading operations.

Poultry Killing Machines Ineffective - Beltsville, MD A paper comparing the effectiveness of poultry killing machines to manual killing, in terms of blood loss per bird was published in Poultry Science. In the study, blood was collected from approximately 99,000 mechanically killed broilers in six plants and 34,500 manually killed birds in two plants. The killing machines in some of these plants were ineffective enough to cause excessive "cadavers"; bloody wing tips or discoloration of the entire carcass causing the birds to be condemned or downgraded. An ineffective killing machine can result in birds being asphyxiated which

can contaminate the body cavity and is inhumane. Since some of the mechanically killed birds bleed slower than manually killed birds, more blood goes into the scald water, which contributes to contamination and wastewater treatment costs.

Microwave Energy Effectively Releases Feathers - Beltsville, MD. Preliminary research findings indicated that microwave treatment of slaughtered poultry effectively released the feathers without damage to underlying tissue. The results suggest that microwave energy may offer a potential alternative to the present method of scalding which requires potable water and energy for heating to 128° F. This adds to pollution problems and creates concern about the microbiological safety of the product. Research conducted in cooperation with Colorado State University could lead to making major changes in commercial poultry processing operations that would increase efficiency and product safety, improve plant sanitation, and reduce energy and water usage and pollution problems.

Feasibility of Direct Producer to Consumer Beef Marketing Studied - Beltsville, MD. An economic feasibility study to establish a direct producer-to-consumer beef marketing venture at the State Farmers Market in Columbia, South Carolina indicated that proposed processing plant, with ancillary retail-sales facilities, would cost \$468,000 to construct and equip; provide job opportunities for 7 meat cutters and one market manager; and generate a potential return of \$56,000 annually to cattlemen participating in the cooperative marketing program. The proposed discount-meat merchandising facility at Columbia will serve initially as a small, pilot-project to refine the proposed direct beef-marketing program. Later, the plant will serve as a demonstration model for other beef marketing cooperatives to emulate.

Demonstrate the feasibility of the modular concept for constructing a shell egg packing plant - Beltsville, MD. Plans and operating procedures were developed for a new shell egg packing plant using the modular concept for a firm that needed to relocate their facilities to reduce operating costs. A centralized parking facility in a city was to be replaced with a facility located on a poultry farm in conjunction with an egg production operation. The firm now has a construction firm estimating costs of constructing the proposed facility. Plans and operating procedures using the modular concept were developed for converting a large pre-engineered warehouse building into a shell egg packing plant with capacity to handle the production from 1.7 million layers. The firm who cooperated in the study now has the plant in operation. Facilities constructed by the firm will serve as demonstrations of the feasibility of the modular concept.

Develop facility modifications in poultry processing plants to meet noise level standards - Beltsville, MD. An experimental wall between the hock cutting-transfer area and the defeathering area of a processing plant has shown that the cumulative effect of many noisy machines such as used in the defeathering room of poultry processing plants can be reduced by separating the machines by insulated partitions. This procedure



has proven to be an effective method of separating most of the personnel from the noise in many plants, since no personnel is needed in the defeathering room except periodic monitoring by one person. Data has been collected and analyzed for a final publication on noise modification in poultry plants.

Collect, analyze, and publish data on the dairy, poultry, and red meat phases of urban food distribution studies - Beltsville, MD. Research work was completed on the Memphis, Tennessee and Newark, New Jersey food distribution studies conducted cooperatively by this laboratory and the Food Distribution Research Laboratory. Historical information concerning the scope of marketing activities in these areas was reported as well as recommendations concerning layouts and cost data for those firms requiring new facilities. Proposed plans for new facilities for dairy, poultry, and meat firms were incorporated into master plans for new food distribution complexes to be located in both metropolitan areas. They include relocation recommendations for 11 dairy, poultry, and meat firms in Memphis and 59 such wholesale firms in Newark and a six-county area in Northeastern New Jersey.

Provide technical assistance to dairy, poultry, and meat organizations referred to the ARS through the Department's Foreign Agricultural Service as well as the Federal meat inspection service within the Food Safety and Quality Service - Beltsville, MD. Assistance was provided to an industry group from Berbera, Somali, East Africa which is interested in marketing imported U.S. beef and native red meat, primarily lamb, from Somali to major markets in Saudi Arabia. The laboratory provided (1) guidelines to assist the group in making an indepth analysis of both the current and long-range potential for supplying these Mid-east markets (2) recommendations concerning various marketing strategies to pursue in establishing hotel, restaurant, and institutional (HRI) accounts and opening retail outlets in Saudi Arabia and (3) research recommendations concerning the shipment, storage, and processing of fresh beef and other meats as well as pertinent material on food distribution facilities.

Develop a commercial dairy plant for converting cottage cheese whey into food products - Beltsville, MD. Research is currently underway to develop a commercial plant system for efficiently converting cottage cheese whey into useable food products while eliminating a major waste disposal problem. Disposing of cheese whey from processing operations has been identified by industry organizations, leading researchers, and governmental agencies as one of high priority. Cheese whey as a plant waste contains the highest percentage of biochemical oxygen demand (B.O.D) and is the most concentrated waste product with which the dairy industry must deal in meeting the pollution standards established by the Environmental Protection Agency (EPA). The system utilizes a fermentation process for recovering yeast protein, which is being evaluated as an ingredient in the processing of other foods. Samples of the product have been used in the preparation of bakery products and snack food items and has shown promising results. Preliminary findings indicate



that the value of the recovered products will off-set the initial investment and operation cost of the system, making it economically feasible for the large number of small to medium size processing plants. Commercial systems are being developed for handling two different volume levels, including a determination of the initial investment and operating costs.

Equipment and methods to reduce moisture content of mechanically deboned poultry meat - Beltsville, MD. Preliminary findings suggest that pressure draining the deboned meat after thawing seems to be the most feasible and consistent when variables are considered such as cost, efficiency in exudate reduction, flexibility and replication of results. There are indications that for every 500 gms of meat, a constant pressure of 5 kg needs to be applied for 24 hours during the thawing process. There appears to be an inverse relationship between the moisture content and the emulsifying capacity.

Design, assembly and operation of instruments and bio-medical telemetry equipment for monitoring the physiological (vital signs) factors which are indicative of stress in cattle before, during and after shipment - College Station, TX. One of our telemetry systems, designated System A, monitors temperature only by means of an ingestible bolus transmitter, which transmits an audible signal whose frequency is proportional to temperature. An earlier limited experiment showed that temperatures transmitted by the bolus (located in the rumen or reticulum) compared favorably with rectal temperature ( $s_x = 0.23^{\circ}\text{C}$ ). However, a more extensive laboratory experiment conducted in July, 1977 with four fistulated Holstein steers showed very poor correlation ( $r < 0.5$ ) between rectal temperature and transmitted rumen/rectulum temperature. This can be attributed to rumen activity - fermentation of food and to intake of water or food. Based on these results, the transmitters have been redesigned to measure temperature adjacent to the tympanic membrane in the middle ear. Both bio-medical telemetry systems were used in the paired shipments made in September and October 1977. Recorded data obtained in these four shipments is stored on cassette tapes and has not been processed because the cassette (Datel) reader malfunctioned. The device was returned to the manufacturer on November 9, 1977 and has not been returned to us. Using our telemetry receiver/recorders in the tractor unit has shown that minor problems do occur during the trip and must be repaired afterwards.

Conduct field studies in selected super market branch houses to increase efficiency for marketing and distributing primal and sub-primal cuts of beef - College Station, TX. Several manuscripts were prepared that outlined the reviews of various segments of the food industry on the subject of pallet and container standardization. A manuscript was prepared which reports research results on boxed beef operations in small volume plants. For example, only a 2¢ spread per pound was noted in total cost variations among seven plants even though labor costs varied from \$2.78 per hour to \$8.00 per hour. It was concluded that more accurate and complete information is needed by the meat industry in

order that more informed decisions can be made by managers. Also, more standardization in cutting methods would permit increased efficiency in small volume boxed-beef plants. Optimum efficiency in boxed beef operations is difficult to achieve when less than 100 head daily are processed on a regular basis. Standardization of box sizes to fit ranges of carcass weights processed, and to efficiently utilize pallets would be helpful to the industry. Definitely, more studies are needed to identify the factors involved that cause damage to boxed meat products, and to determine the extent that such damage can be controlled in storage and transit. A failing found in many small volume plants was that adequate quality control measures are not taken to assure that primal and subprimal cuts meet specifications, or to maintain the high standards of sanitation that are so important to the boxed beef customer.

Complete manuscript on how small meat packing plants can reduce energy requirements and pollution - College Station, TX. Research results show that small plants can reduce waste-water pollution and usage of water, electricity, and natural gas or propane by changing work procedures, upgrading equipment and facilities and operating slaughter floors at or near capacity. If slaughter floors were operated at capacity, 10 of the 11 plants studied could reduce annual water usage by 3 to 32 percent and energy usage by 2 to 21 percent. An edited manuscript entitled "Utility Usage in Small Slaughter Plants" was completed.

Althen, T. G., K. Ono and D. G. Topel. Effect of Stress Susceptibility or Stunning Method on Catecholamine Levels in Swine. J. Animal Sci. 44:985. 1977.

Anderson, M. E. and D. R. Hammons. An Overview of Pallet Standardization in the Food Industry. ASAE paper No. 77-6004. 12 pp. 1977.

Anderson, M. E., R. T. Marshall, W. C. Stringer, and H. D. Naumann. Combined and Individual Effects of Washing and Sanitizing on Bacterial Counts of Meat - A Model System. J. Food Prot. 40(10): 688-670. 1977.

Anderson, M. E. and R. T. Marshall. Effect of Concentration of Detergent and Temperature of Solution During Cleaning of a Milk Contact Surface. ASAE Paper No. 77-6006. ASAE Headquarters, St. Joseph, Mich. 1977.

Anderson, M. E. and D. R. Hammons. Standardization of Pallets Can Improve Efficiency. The Packer. Feb. 11, 1978.

Arthaud, V. H., R. W. Mandigo, R. M. Koch and A. W. Kotula. Carcass Composition, Quality and Palatability Attributes of Bulls and Steers Fed Different Energy Levels and Killed at Four Ages. J. Anim. Sci. 44: 53-64. 1977.

Bassett, Harold J., Dean S. Shelley and M. E. Anderson. Processing Coffee Whitener in a Pilot Processing Unit. American Dairy Review. Feb., 1978. pp. 3537.

Berry, B. W., J. A. Maga, C. R. Calkins, L. H. Wells, Z. L. Carpenter, H. R. Cross and F. C. Parrish, Jr. Flavor Profile Analyses of Beef Loin Steaks. Western Section, Amer. Soc. Anim. Sci. Proceedings. 28:77.

Bittel, Ralph J. and Paul P. Graham. A Qualitative Spot Test for the Detection of Spleen added to Ground Beef. Virginia Polytechnic Institute and State University Research Division Bulletin 125. 1977.

Brassington, C. F. and D. R. Hammons. What a Small Plant can do about EPA Water Standards. Meat Ind. 23(2):42, 45. 1977.

Brassington, C. F. Water Usage in Small Plants. Meat Plant 38(3):28-30, 40, 42, 44. 1977.

Brassington, C. F. Energy Use in Small Plants. Meat Plant 38(5):20, 22, 24, 25. 1977.

Brassington, C. F. and D. R. Hammons. Calculate your Storage Space for Offal. Meat Ind. 23(1):33. 1977.

Brassington, C. F. and D. R. Hammons. How Much Freezer Capacity Does a Small Plant Need? Meat Ind. 23(4):35. 1977.

Brassington, C. F. and D. R. Hammons. Protect Product Quality with the Right Cooler Design. Meat Ind. 23(5):46. 1977.



- Brassington, C. F. and D. R. Hammons. Improve Flow with Dock, Storage Location. Meat Ind. 23(6):75. 1977.
- Brassington, C. F. and D. R. Hammons. How to Plan a Sewage System. Meat Ind. 23(7):59. 1977.
- Brassington, C.F. and D. R. Hammons. Space Needs for Offices, Inspector, and Workers. Meat Ind. 23(9):56. 1977.
- Brasington, C. F. and D. R. Hammons. How to Estimate Utility Needs for a Small Plant. Meat Ind. 23(10):84. 1977.
- Chesnut, C. M., B. S. Emswiler, A. W. Kotula and E. P. Young. Bacteriological Quality of Ingredients Used in Ground Beef Manufacture. J. Anim. Sci. 44:213-217. 1977.
- Cross, H. R. Effect of Amount, Distribution and Texture of Marbling on Cooking Properties of Beef Longissimus. J. Food Sci. 42:182-185. 1977.
- Cross, H. R., E. C. Green, W. R. Jones, R. West and A. W. Kotula. Beef Slaughtering, Cutting, Preserving and Cooking on the Farm. Farmers' Bulletin 2263, 1977.
- Cross, H. R., E. C. Green, W. R. Jones, R. West and A. W. Kotula. Lamb Slaughtering, Cutting, Preserving and Cooking on the Farm. Farmers' Bulletin 2264, 1977.
- Cross, H. R., E. C. Green, W. R. Jones, R. West and A. W. Kotula. Pork Slaughtering, Cutting, Preserving, and Cooking on the Farm. Farmers' Bulletin No. 2265. 1978.
- Cross, H. R. and Marilyn S. Stanfield. Consumer Evaluation of Restructured Beef Steaks. J. Food Sci. 41:1257-1258. 1976.
- Cross, H. R., J. Stroud, Z. L. Carpenter, A. W. Kotula, T. W. Nolan and G. C. Smith. Use of Mechanically Deboned Meat in Ground Beef. J. Food Sci. 42:1496. 1977.
- Harris, C. E. and T. A. Carter. Broiler Blood Losses with Manual and Mechanical Killers. Poultry Sci. 56:5 1827-1831, Nov. 1977.
- Harris, C. E. Methods and Facilities for Grading Broilers and Turkeys. MRR No. 1091, 1977.
- Hayden, Alonza R. Detection of Chicken Flesh in Beef Sausages. J. Food Sci. 42:1189. 1977.
- Kotula, A. W., G. G. Twigg and E. P. Young. Evaluation of Beef Patties Containing Soy Protein During 12 Months Frozen Storage. J. Food Sci. 41:1142-1147. 1976.
- Kotula, Q. W., B. S. Emswiler, and C. J. Pierson. Inhibition of Bacterial Growth with Aqueous Chlorine. European Meat Research Workers Meeting. 1977.

Lin, T. S., R. E. Levin and H. O. Hultin. Myoglobin Oxidation in Ground Beef: Microorganisms and Food Additives. J. Food Sci. 42:151-154. 1977.

Marshall, R. T., M. E. Anderson, H. D. Naumann, and W. C. Stringer. Experiments in Sanitizing Beef with Sodium Hypochlorite. J. Food Prot. 40(4):246-249. 1977.

Mercuri, A. J., N. A. Cox, M. O. Carson and D. A. Tanner. Relation of Enterobacteriaceae counts to Salmonella Contamination of Market Broilers. J. Food Protection. Vol. 41, No. 6, pp.427-428, June 1978.

Ono, K., T. G. Althen and K. Mahen Cyclic AMP Concentration During Slaughter of Pigs. J. Anim. Sci. 43:1000-1003. 1976.

Ono, K., D. G. Topel, and T. G. Althen Adenylate Cyclase and Cyclic 3', 5'-Nucleotide Phosphodiesterase Activities in Muscles from Stress-susceptible and Control Pigs. J. Food Sci. 42;111-112. 1977.

Ono, K., D. G. Topel, L. L. Christian and T. G. Althan Relationship of Cyclic-AMP and Phosphorylase a in Stress-Susceptible and Control Pigs. J. Food Sci. 42;108-110. 1977.

Ono, K. and T. G. Althen Cyclic AMP Concentration and Pale, Soft, Exudative Pork. Proceedings of the 22 Meat Congress, Malmo, Sweden, August 30-September 3, 1976.

Overheim, R. K., J. N. Morris, Jr., C. E. Harris, H. R. Smalley and C. F. Stewart. Food Distribution Facilities for Ashville, North Carolina. MRR No. 1069, June, 1977.

Shupe, W., J. W. Goble, A. W. Brant and J. A. Hamann. A Partially Mechanized Raw Fowl Boning Method. Transactions of ASAW. Vol. 20, No. 1, pp. 194-197.

Smith, W. A. and C. F. Stewart. Pilot Plant Studies on the Reduction of Chemical Oxygen Demand of Cottage Cheese Whey. Oklahoma State Animal Science Res. Rpt. 1977.

Stewart, C. F. Comparative Analysis of a Remodeled Versus a New Dairy Products Processing Plant. MRR No. 1086, 1977.

Stewart, C. F. Economic Feasibility of a Small On-the-Farm Milk Processing Plant. MRR No. 1087, 1977.

Stewart, C. F. (co-authorship). Report of a NE Research Program Steering Committee. Dairy, Sept. 1977.

Steel, N. C., T. G. Althen and L. T. Frobish. Biological activity of Glucose Tolerance Factor in Swine. J. Animal Sci. 45:1341. 1977.

- Topel, D. G., J. A. Miller, P. J. Berger, R. E. Rust and K. Ono. Palatability and Visual Acceptance of Dark, Normal and Pale Pork. J. Food Sci. 41:628-630. 1976
- Twigg, G. G., A. W. Kotula and E. P. Young. Consumer Acceptance of Beef Patties Containing Soy Protein. J. Anim. Sci. 44:218-223. 1976.



NRP ANNUAL REPORT  
FY 1977

National Research Program 20610

TECHNOLOGIES AND FACILITIES FOR MARKETING ACROSS COMMODITIES

This ARS-NRP is one of four dealing with Marketing Efficiency under the Department's Program No. 617: Marketing Efficiency Research. This research involves study of technologies that are universally applied to a wide range of agricultural commodities as with transportation, packaging, refrigeration, storage, instruments for measuring quality, marketing facilities, farmers markets or total distribution systems. The overall USDA mission relates to Agricultural Marketing Efficiency and the operating goal is research for new products and processes and for reducing marketing costs.

NPS Contact: D. L. Anderson

PACS Contact: C. Golumbic

Technological Objective 1:

Develop new and improved technologies for maintaining product quality and reducing losses in the marketing channels.

Research Locations:

Beltsville, Maryland

Selected Examples of Recent Progress:

Transport of meat by railroads - Beltsville, MD. Improve the efficiency of transporting fresh meats from packinghouse to consignee using refrigerated trailers moving by railroad; and to evaluate and improve the present handling procedures, equipment cleaning and equipment performance to determine where significant improvements can be made in the distribution of fresh meats. In addition to the information gathered through literature searches and interviews with industry representatives on equipment, practices, and procedures to properly clean and sanitize meat trailers, results of studies on the use of several types of detergents in automatic high pressure cleaning equipment have been obtained. These research results as well as the information on types of mechanical and automatic cleaning equipment, types of chemical cleaning and sanitizing compounds, cleaning practices and procedures, trailer design, and other factors are being incorporated in a manual for distribution to the meat and transportation industries. Additional studies to identify the type of debris and contamination found in meat hauling equipment after it is used for a variety of backhauls have been planned to determine effective cleaning and sanitizing programs.

Improved refrigerated railcar - Beltsville, MD. (1) Measure capacity of each type of air circulation system to reduce sensible heat (initial heat load) of given quantity of fruit to determine feasibility of using bottom-air delivery cars to precool shipments before transport; (2) measure loading cooling and temperature maintenance capacity of each type of air circulation system in transit from California to eastern markets; (3) determine effects of heavier loading and different cooling rates on fruit quality and condition and on physical damage of the product; and (4) determine type, size, and location of ventilation holes in boxes and slipsheets required to facilitate effective air circulation through the boxes in tightly-stacked unitized loads.

Two conventional refrigerated railcars have been modified to direct refrigerated air under the load for forced-air cooling. Three refrigerated railcars, each with a different type air distribution system, were compared in a stationary test. The cars were loaded with lemons and a pull-down test conducted. The three railcars were instrumented with temperature and humidity recording instruments. Temperature and humidity data were gathered and will be compared to similar data gathered in transit tests.

Distribution of fresh beef - Beltsville, MD. Determine the effectiveness and costs of different types of treatments, packaging, handling, and transport environments on maintenance of quality, shelf life, and consumer acceptability of fresh meat.

Laboratory studies on the condition and treatment of fresh meat prior to packaging have identified the type of micro-organisms present and have shown a means of reducing the microbial growth through the use of chlorine washes. Studies on the effects of post-mortem chill, type of packaging material, and degree of vacuum showed that fresh meat having a low microbial count that was thoroughly chilled prior to vacuum packaging at a high level of vacuum and was stored at temperatures near freezing had the longest shelf life. Data on commercial shipments of fresh beef showed that the use of polyvinyl chloride film was economically feasible for shipments exceeding 36 hours in duration, whereas, vacuum packaging was feasible for shipments of 10 days or more. Shipping fresh beef in containers with a modified atmosphere (60% CO<sub>2</sub>, 25% O<sub>2</sub>, 15% N<sub>2</sub>) showed reduced microbial counts and maintained the fresh beef appearance longer than beef shipped in containers of normal atmospheres. The use of modified atmospheres was feasible for fresh beef shipments requiring 7 or more days' transit time. These studies have revealed some methods of extending shelf life and maintaining the condition during storage, distribution, and marketing of fresh meat.

Cleaning railroad cars - Beltsville, MD. (1) Review present technology and economics for cleaning box and covered hopper cars. (2) Evaluate the feasibility of transferring cleaning technologies from other industries.

- (3) Develop recommendations for practical and objective methods of determining the degree of cleanliness and/or sanitation of railroad cars.
- (4) Determine technical and economic feasibility of improving cleaning systems for rail carriers or contract railcar cleansers.
- (5) Determine technical and economic feasibility of improved railcar cleaning systems for shippers.
- (6) Develop a tentative program for future SEA/FR research concerning clean railroad cars for transporting food and feed.

The contract was completed and the final report from the contractor was delivered to the USDA in May 1977. All the objectives were satisfactorily completed. Six major short-and long-range needed research projects were identified and ranked according to earliest beneficial returns. Example of short-range project--Adding cleaning and sanitizing agents to heated water for washing covered hopper cars. Example of a long-range project--Develop new car designs which are amenable to cleaning. The final report is being rewritten to shorten, clarify, and illustrate with pictures for a USDA publication.

#### Technological Objective 2:

Develop new and improved techniques of quality measurements for use in grading, standardization and inspection programs and as a base for consumer protection.

#### Research Locations:

Beltsville, Maryland

#### Selected Examples of Recent Progress:

Develop a rapid method to predict amino acid content of food products - Beltsville, MD. Near-infrared reflectance spectra have been measured for each of 25 pure amino acids including all of the essential amino acids. These spectra show distinct differences with no two spectra being the same, so the technique can readily distinguish pure amino acids with no sample preparation other than placing solid samples in the sample compartment.

Near-infrared reflectance spectra have been measured on wheat, corn, barley, and rice samples for amino acid content. We have been successful in using the technique to predict 17 amino acids in wheat, and lysine content of barley and rice. Results have not been satisfactory on corn in predicting lysine, but much of the problem appears to be related to the chemical data.

Develop improved nondestructive techniques for evaluating apple quality - Beltsville, MD. Light transmittance and sonic resonance studies of intact apples have continued in cooperation with the Horticultural Crops Marketing Laboratory. Statistical analyses have not been completed on all the data, but the completed analyses indicate that



light-transmittance measurements correlate better to taste panel scores than sonic-resonance measurements. Light-transmittance measurements of optical density differences ( $\Delta$  OD) between 660 and 700 nm gave correlation coefficients of 0.91 for acidity score and 0.92 for astringency score on 'Golden Delicious' apples. The respective correlation coefficients were 0.95 and 0.87 for 'York' apples. The wavelengths giving these optimum correlations are wavelengths most sensitive to chlorophyll content. Chlorophyll content is a good measure of maturity in apples if growing conditions are held constant, but if growing conditions vary, chlorophyll content can be greatly altered without changing maturity. Therefore, the high correlations obtained here need to be verified.

Develop a rapid method for estimating the moisture content of individual kernels of corn - Beltsville, MD. A near-infrared transmittance technique has been shown to be useful in measuring the moisture content of individual kernels of corn over a very wide moisture range. Spectral transmittance measurements from 700 to 1100 nm on 400 kernels of corn yielded data which could be used to predict moisture content. Optical density differences between 950 and 920 nm on individual kernels correlated linearly ( $r = 0.96$ ) with oven moisture determinations on the same kernels. A standard error of 2% moisture content was obtained in predicting samples having a moisture range from 10 to 35%. A part of this error is caused by the oven determinations of moisture and further work is needed to determine the accuracy of the near-infrared transmittance technique.

The near-infrared reflectance technique for measuring the protein content of wheat has been improved by developing data treatments which compensate for particle size and moisture content. Standard errors in predicting unknown samples with large particle size variation and wide moisture range were reduced from 0.6 to 0.27% with new data treatment compared to the previous methods. This improvement removes much of the sources of error from near-infrared measurements.

The Federal Grain Inspection Service has adopted the near-infrared technique for use in grading of wheat and purchased 95 instruments for this purpose. Beginning May 1, 1978, official certification of protein content of wheat will be provided using this new procedure. With our cooperation, the next effort will be toward oil and protein measurement of soybeans.

### Technological Objective 3:

Reduce costs in distribution and marketing systems by increasing physical efficiency, reducing energy requirements, and improving work methods.

#### Research Locations:

Orlando, Florida  
Beltsville, Maryland  
Yakima, Washington

#### Selected Examples of Progress:

Refrigeration characteristics of trailers - Orlando, FL. Study the variables relevant to transport equipment evaluation such as the physical characteristics of the cargo, the cargo space and outside environment, the environmental control system, and the method of loading: A test was conducted on a conventional reefer trailer when the ambient temperature ranged from 25° to 33°C (avg. 30°), and the roof skin temperature ranged from 30° to 78° (avg. 41°). Relative humidity (dew point) and temperature were taken at 5-minute intervals and found to range from 84% at 0° to 76% at 22° (avg. 85% at 12°) in the rear of the trailer where the discharge air is located. In the front of the trailer where the return air is located, the range was 50% at 7° to 82% at 21° (avg. 72% at 14°), and at mid-center, the range was 74% at 5° to 71% at 21° (avg. 81% at 13°). The thermostat setting was 4°.

Food marketing in rural areas - Beltsville, MD. A study has been completed on developing, planning, organizing, and operating farmers' markets. A draft of a report of the study is being finalized for publication. Eight markets of different sizes and types were studied to provide facts and practical information for planners, organizers, and managers of retail-type farmers' markets.

Grain container system - Beltsville, MD. Further develop the concept for storage and handling of grain in containers from the farm to end user. This research relates to that part of the TO concerned with reducing costs and improving the methods for the physical distribution of grain.

A study was made of a river terminal grain storage elevator in Kansas City, Missouri, for the purpose of developing a description of the basic equipment and sequence of flow of grain in a typical terminal elevator. Data developed in the study will be published in a report describing the present system of handling, transportation, and storage involved in moving grain from the farm to the processor in the United States and overseas. Since there is presently no substantive literature describing the present system, identifying its main characteristics and problems, it was decided to develop information for such a report as a necessary first step in the research to determine the feasibility of a containerized storage, transport, and handling system for grain.

Energy reduction for frozen foods - Beltsville, MD. Determine the amount of energy saved when shutting down refrigeration overnight in frozen food storage rooms storing different types of frozen food under different temperature conditions, determine the amount of quality losses associated with this practice, and determine methods of increasing the freezing rate of boxed meats in conventional freezing systems by varying pallet stacking patterns, box design and sizes, and air-blast velocities: This relates directly to the T0 through reduction of energy requirements for storing frozen foods.

Pallet lots of commercially-packed frozen peas, okra, and strawberries were stored for 1 year in four temperature conditions:  $-23^{\circ}\text{C}$ , constant;  $-23^{\circ}\text{C}$  daytime and  $-18^{\circ}\text{C}$  nighttime;  $-20.5^{\circ}\text{C}$  daytime and  $-18^{\circ}\text{C}$  nighttime; and  $-18^{\circ}\text{C}$  daytime and  $-15^{\circ}\text{C}$  nighttime. An energy savings of up to 20 percent was gained by storing food in the  $20.5^{\circ}$  to  $-18^{\circ}\text{C}$  range compared to the  $-23^{\circ}\text{C}$ , constant temperature. Product stored in the  $-18^{\circ}$  to  $-15^{\circ}\text{C}$  range was of marginal quality after 6 months. Product stored at peripheral locations of the pallet loads was affected most by the fluctuating room temperatures and quality damage was extensive at these locations after 12 months' storage.

Hopper-bottom boxcar - Beltsville, MD. Evaluated, in the railroad operating and physical distribution system environments for bulk agricultural and various types of packaged agricultural and nonagricultural products, two prototype hopper-bottom boxcars as a potential method for reducing the seasonal car shortages and costs of transporting grains and soybeans: A total of 22 experimental shipments were made in the two prototype cars brought into the United States from Canada for evaluation. Shipments consisted of barley, corn, and wheat in bulk and tissue paper, beer, and lumber. The tests disclosed that the side doors need to be redesigned and strengthened. It was observed that the bulk materials could be loaded into and unloaded from the cars with about the same degree of efficiency as when conventional covered hopper cars are used. Packaged and palletized products also could be handled as well as in both cars. The cars were found to be too small to obtain satisfactory payloads for both bulk and packaged products. It also was found that the cars needed to be redesigned to reduce their tare weights. Performance and cost data developed in the tests are being evaluated.

Complete phases of trust fund apple project - Yakima, WA. A total of four test shipments were completed during CY 1977 encompassing work with four packinghouses and three large eastern supermarket chains. Data is being analyzed by Biometrical and Statistical Services staff, SEA/FR, at Fort Collins.

Study of apples from packinghouse to retail - Yakima, WA. This project enables scientists to identify injury throughout the entire distribution system. To obtain maximum benefits from the distribution system it must



be considered as a whole and not in isolated sections. The cost of distribution of fruit (which includes losses) which includes preparation, packaging, transport, marketing and retailing is escalating at a faster rate than production costs. Basic data on physical injury occurring at the various points in the distribution system will lead to reduction of the estimated 15 to 40% of fresh food losses and in reduction of the marketing bill for food.

Feasibility of a new metric container design to reduce losses and material cost of bag packs - Yakima, WA. Analysis of tests were completed and a paper is being prepared for presentation at the 1978 summer meeting of the ASAW. Also, a manuscript is under preparation for USDA publication of the 50 X 30 cm container.

Evaluating cost and performance of alternative types of bins for tray-pack apples - Yakima, WA. Cooling rates and temperature maintenance studies of alternative bin types were done on a limited basis.

Feasibility of using a liquid polyurethane foam system that encapsulates and cushions the product in a shipping container - Yakima, WA. Information gained from contact with various manufacturers of this material resulted in giving this project a lower priority. A major problem is cost and availability of equipment at this time. Only three suppliers are known to have national distribution and none were able or willing to provide necessary assistance for laboratory experiments at this time.

#### Technological Objective 4:

Improve Integration of individual functions in the marketing system to increase efficiency of total system.

#### Research Location:

Beltsville, Maryland

#### Selected Examples of Progress:

Determine Costs for Different Systems of Marketing potatoes from Grower to Retail Store - Beltsville, MD. This research has been divided into three phases. The first phase is completed and results published on methods of harvesting, loading the truck, transporting from field to packing house, and unloading. The second phase included packinghouse operations and has been completed and published. The third phase includes movement of potatoes from the packing house, to wholesaler receiver and retail store. One of the objectives in last year's plans was to conduct research on shipping potatoes in bins from the packing house, through the distribution warehouse to retail store. Studies were conducted and completed in cooperation with the Red River Valley Potato Research Laboratory and the Market Pathology Laboratory, Chicago, Ill.

Development of Improved Physical Distribution System for Marketing Fresh Tomatoes - Beltsville, MD. As planned last year, research was completed on two systems of harvesting and handling fresh tomatoes from field to packing plant. The study showed that by using permanent wooden field boxes (50-lb capacity) to load and transport tomatoes to the packing plant a savings of \$3.61 per ton is realized over use of disposable fiberboard boxes (30-lb capacity) to perform the same function. A report documenting the findings has been edited and is in the process of being printed. Studies have been conducted in food wholesale warehouses to determine costs for receiving, storage and order assembly. A cooperative study was conducted with the Horticultural Crops Marketing Laboratory, to develop costs for a new system of tomato marketing. In this system tomato harvesting and consumer packing would be done in the field and tomatoes transported directly to the retail store. This system eliminates the packing plant and wholesale warehouse in existing marketing systems. Cost per pound is slightly higher with the new system as compared to the conventional system, but a higher quality product with less damage and better taste may be the result. The projected findings in this study have been prepared, edited and are now in the printing process.

Determine Costs for Different Systems of Marketing Shell Eggs from Packing Plant to Retail Store - Beltsville, MD. The objectives set forth for Calendar Year 1977 included the computerized statistical analysis of damage data to determine eggshell damage relationships by type of master container and stacking pattern of cartons within, age of laying bird, and climate conditions. Publication of the results was also scheduled for 1977. The analysis has been completed, the report has been written, a peer review has been completed, and editing of the manuscript is near completion.

Systems for Marketing Fresh Cherries - Beltsville, MD. Plans were to be made and a CRIS project prepared for a comprehensive research project on systems of marketing fresh cherries. An intensive preliminary survey was made in the State of Washington on harvesting and packing methods of fresh cherries. In addition, a secondary search was made and interviews with key industry representatives were obtained. It was decided, with the concurrence of industry and trade contacts, that a systems study would not be feasible at this time. This is primarily for three reasons: (1) The brevity of the fresh cherry season; (2) the highly individualistic nature of the relatively few fresh cherry operations which prevents realistic comparisons; and (3) lack of manpower to conduct an adequate study.

Improved Systems for Shipping Groceries from Manufacturer to Wholesale Warehouse - Beltsville, MD. The objective to develop a cost model for use of a second size unitized shipment program from manufacturer to distribution warehouse has been achieved. A report documenting findings in the study is in preparation and shows that implementation of a second size unit load is more costly than the current practice of repalletizing



groceries at the distribution warehouse when a pallet size other than 48- by 40-inch is used. The objective to initiate a study on consolidation of retail store vendor deliveries in cooperation with the Food Distribution Laboratory was not initiated because of the lack of combined resources in the two laboratories. Another study was initiated on the possibility of unitizing truck transportation from manufacturer to distribution warehouse on slipsheets. Since truck transportation accounts for 70 percent of such deliveries, unitization of such shipments has the potential for substantial savings in marketing grocery products.

Evaluate Systems for Handling and Transporting Frozen Food From Processing Plant to Wholesaler - Beltsville, MD. Research was completed on a study to determine the costs for the two major vending methods for ice cream marketing from wholesaler to retailer. The study showed that by using the telephone call-in system of placing orders and subsequent delivery, labor cost was 7.98 cents per package as compared to using the driver-salesman method of delivery where labor cost was 12.40 cents per package. By using the call-in system, labor savings for a 300 package delivery load would be \$13.26. A report documenting the findings has been edited and is in the printing process.

Cooperation with an ice cream company and a frozen food processor was initiated for the purpose of inplant testing of permanent pallets under plant operating conditions. The one-year inplant pallet test will be completed within three months.

Marketing Beef from Slaughterhouse to Retail Store - Beltsville, MD. A study to determine costs of two systems for handling prefabricated cuts of beef between the distribution warehouse and retail stores has been completed. The final report has been written and will be submitted for peer review shortly. The study showed that the system which used wire baskets and dollies had a total cost of \$.62 per hundredweight of product while the system which used corrugated cartons cost \$1.37. Included were costs of labor, equipment, and materials. The cost of the carton system can be reduced by increasing the number of uses per carton, but not enough to approach the cost of the wire basket system. A contractor study on "Systems for Marketing Beef from Slaughterhouse to Retail Food Store" has been terminated due to unacceptable contractor performance.

Determining Costs for Energy in Marketing Fresh Beef from Slaughterhouse to Retail Display Case: (CRIS Work Unit #1090-20614-001C) The objective of this study is to determine energy costs in the fresh beef marketing system from slaughterhouse to retail display case, examine alternate, more efficient systems, and identify areas for potential cost reductions. The contractor, Globe Engineering Company, has prepared a model of five common beef marketing systems to include all processing, handling, packaging, storage and trans-functions. The models begin with the chilling of the "hot" carcass and end with the retail package being removed from the display case by the the consumer. The contractor is conducting additional needed research as specified in the contract. A final progress report will be made for the CRIS unit upon receipt and acceptance of a report from the contractor.



Evaluation of Systems and Environment for Feeder Livestock During Shipment from Production Areas - Beltsville, MD. Three of the four planned instrumented test shipments consisting of two trialer loads of calves in each shipment was conducted. Two of the shipments went from Allgood, Tennessee to Bushland, Texas and one went from Memphis, Tennessee to El Reno, Oklahoma. Data on animal weight loss, death loss, physical condition, and weight gain after the shipment was gathered. Animal vital signs, transport environment and outside weather conditions were monitored while intransit. Participated in the activities and plans of the Shipping Fever Project Coordinating Committee.

Development of Improved Physical Distribution Systems for Citrus Fruits Beltsville, MD. An article detailing the results of a study of eleven disposable pallets for possible use in palletized and unitized handling and shipping systems for fresh fruits and vegetables was published. After disposable pallets were evaluated, only the corrugated fiberboard slipsheet met the established criteria for both performance and cost. An article was written by a leading trade publication highlighting the aforementioned study and its value. An article was published comparing this recent disposable pallet evaluation and a past evaluation of disposable pallets was published. Two studies conducted six years apart and on a basically different and diverse groups of disposable pallets showed the same basic result, other than the fiberboard slipsheet the disposable pallets studies were either too expensive or too flimsy to meet the requirements for handling fresh fruit and vegetables. A manuscript evaluating systems for warehouse receiving, order assembly, and delivering citrus to retail stores has been written and is in the final stages of the editorial process. Permanent pallets were placed in commercial use at two locations and their performance and condition has been monitored throughout the year.

Determine Costs for Different Systems of Marketing Fresh Dry Onions from Grower to Retail Store - Beltsville, MD. As planned last year, detail studies on productivity and costs were conducted with cooperators in southern Texas and in New York on the harvesting, loading, transporting from the field to the packing shed and unloading. The data collected has been analyzed and a harvesting report of the findings is in the initial stages of being written. Additional studies will be needed in other producing areas before a final report is prepared.

Technological Objective 5:

Develop methods to increase the efficiency of consumer marketing to reduce costs, insure consumer protection, and improve customer services and satisfaction.

Research Location:

Beltsville, Maryland

Selected Examples of Recent Progress:

Food marketing in urban areas - Beltsville, MD. A study outlining recommendations for improvements for the food industry in Northeastern New Jersey has been completed and presentation of study findings has been made to local State and industry officials. A site of at least 400 acres would be required to provide the appropriate facilities and space for 176 food firms included in the master plan for a new food distribution center. Investment costs are estimated between \$133 to \$164 million depending on which of the seven sites evaluated in the study is selected. Initial food center development would require more than 3 million square feet of first-floor space. Total annual volume of food products to be handled initially is estimated to be 1.4 million tons. If present trends continue, the annual volume should increase to about 2.4 million tons in the next 30 years.

A study has been completed and a report describing the study and recommendations has been published on improving the wholesale food marketing and farmers' market facilities in Asheville and a 20-county area of western North Carolina. The first phase of construction on the new \$2.4 million western North Carolina farmers' market is completed. The market was officially opened in September with over 3,000 persons attending the dedication ceremonies.

A public presentation outlining the results of the study to improve the wholesale food facilities of Memphis was made on June 29, 1977, to officials of the city, county, and State, and to regional planning officials, members of the local food industry, and others concerned with food marketing in the area. A report has been written and is being finalized for publication.

The study has been completed on sources of financing for food distribution centers and a report has been drafted for publication.

Wholesaling: methods, equipment, and facilities - Beltsville, MD. Conducted a literature search to determine any research closely related to logistics in food distribution to inner-city food stores and the preliminary stages of the field work have been started.

Completed reports for Departmental publication discussing the results and recommendations of the following studies: (1) Evaluating various methods and systems for handling frozen foods from warehouse receiving to retail stores; (2) improving the food service industry in Bridgeport, Conn.; and (3) the impact of various temperatures and holding times on the quality of frozen foods.

Completed a manuscript on 13 delivery systems.

Initiated a study of systems for handling customer orders. Initial investigation has been made and scope of project enlarged to include

evaluation of distributed data processing and application of cathode ray tubes to specific warehouse control such as receiving and stock locator systems.

Retailing: methods, equipment, and facilities - Beltsville, MD.

Determine the potential energy savings that would accrue from consolidated delivery systems: A preliminary plan of work was discussed with researchers at Pennsylvania State University as a logical extension of the research previously conducted under cooperative agreement with that institution. This project has been deferred pending availability of funds. Participation at meetings of the Urban Goods Movement Committee and the Food System Energy Task Force (Pennsylvania) have provided a source of input and a means of keeping abreast on energy related transportation problems in the food distribution area.

A review of literature on produce handling practices was begun during the past year. Emphasis is being given to the need for updating and supplementing out-of-date USDA publications on produce operations. Details of the research and possible cooperators have been discussed with researchers at USDA and land grant universities.

Evaluate the results of the study on cleaning and sanitation activities in four typical food stores: The manuscript was completed and reviewed and is now in press.

Determine the costs and problems associated with locating and operating retail food facilities in low-income areas and make recommendations for improvements that will improve the efficiency and help hold down the costs of food to consumers: A plan for studying central city food marketing problems was formulated to include all aspects of the food distribution system in a given urban area. An extensive literature review was conducted and the effort in Washington, D.C. was expanded to include research on wholesaling activity and alternative means of marketing in that city. An analysis of the entire network of retailing establishments within the central city was begun during the latter part of the year and is still underway. This will provide a profile of the retailing elements of the system and indicate needs for expansion and development of operations. A contract was awarded to develop a methodology to measure the impact of the food distribution system upon consumer nutrition. The emphasis of this research is on the inner-city area. Literature review and preliminary data gathering began in late 1977.

Provide information and technical assistance on computerized checkout systems to the industry and consumers as requested, plan and initiate an in-store evaluation of computerized checkouts: State-of-the-art developments have been monitored on a continual basis and a research plan has been developed to evaluate the costs and benefits of the computerized system. The evaluation has not yet been initiated, pending the procurement of cooperators.



Food Service: methods, equipment, and facilities - Beltsville, MD.

Determine least cost food service systems for construction of new hospitals: Acted in the capacity as ADODR on a contract with James A. Mixon and Associates and a cooperative agreement with the Fairfax Hospital. An extensive literature search was conducted and completed under contract by James A. Mixon and Associates which determined the extent of hospital food service productivity research. Based on these findings, a cooperative agreement with the Fairfax Hospital was developed and studies were jointly conducted of a convenience food system, a ready-food system, and a conventional food system.

Develop and implement a procedures manual to improve food quality and reduce loss in food service establishments: A draft manuscript is being prepared for publication.

Determine the economic feasibility of a model dishwashing system: Memorandums of understanding between the Vulcan Hart Corporation, the U.S. Army Troop Support Agency, and the Department of Agriculture were negotiated. Engineering drawings and projected operating costs for the model system have been developed. In addition, labor requirements for a comparable dishwashing system located at Savannah, Ga., were completed.

Develop a predictive mathematical model for a fast food restaurant: Statistical data on the sales of specific menu items over a one year period has been analyzed and mathematical formulas predicting trends have been developed.

Evaluate labor productivity in selected cafeterias: Productivity data from six cafeterias and final report has been received from a contractor.

PUBLICATIONS

Orlando, Florida

Hinsch, R. T., R. H. Hinds, Jr., and W. F. Goddard, Jr. Lettuce temperatures in a van container with a reverse airflow circulation system. USDA, ARS, Marketing Res. Rpt. No. 1082. 4 pp. 1978.

Beltsville, Maryland

Anthony, J. P., Jr. and R. C. Mongelli, Evaluation of Various Types of Disposable Pallets. Outlook Annual Report of the United Fresh Fruit and Vegetable Association, Vol. IV, No. 1, Jan-Feb, 1977, pp. 23-28.

Anthony, J. P., Jr. An Evaluation of Costs of Alternative Systems for Receiving and Delivering Citrus. ARS-NE-95.

Anthony, J. P., Jr. Disposable Pallet Evaluations. The Produce News, Nov. 12, 1977, Vol. 80, No. 45, p. 4.

Asen, Sam, Robert N. Stewart and K. H. Norris. Anthocyanin, Flavonols, and pH involved in the color of 'Heavenly Blue' morning glory. Phytochemistry 16:1118-1119. 1977.

Ashby, B. H., A. H. Bennett, W. A. Bailey, A. Kramer and W. Moleeratanond. Energy Savings During Frozen Food Storage. Amer. Soc. of Ag. Eng., Paper No. 77-6527, St. Joseph, Mich. 1977.

Bouma, J. C. Six Principles for Developing Savings in Produce Warehouses. Outlook Annual Report of the United Fresh Fruit and Vegetable Association, Vol. IV, No. 1, Jan-Feb, 1977, pp. 64-68.

Bouma, J. C. and P. F. Shaffer Systems for Handling Groceries from Supplier to Distribution Warehouse. MRR 1075.

Bowling, R. A., Z. L. Carpenter, G. C. Smith and K. E. Hoke Vacuum Packaging Systems for Subprimal Beef Cuts. Jour. Anim. Sci. 45:1280-1288. 1977.

Breakiron, P. L. Engineering Better Interfacing of the Load, the Transport Vehicle, and the Refrigeration Unit for Improved Transportation. Proc. Int. Soc. Citriculture, 1:288-293. 1977.

Cline, J. L. and H. S. Ricker. Research on the Small Food Store Supply System. Proceedings 28th Annual Conference, American Institute of Industrial Engineers, pp. 379-383, 1977.

Cline, J. L. A Simulation Approach to Analyzing Alternative Distribution Systems for Small Food Stores. Journal of Food Distribution Research, Vol. 8, No. 1, pp. 99-100, 1977.

Marriott, N. G., G. C. Smith, K. E. Hoke, Z. L. Carpenter, and R. L. West. Long-Distance Transoceanic Shipments of Fresh Beef. Jour. Food Sci. 42:316-320. 1977.

Marriott, N. G., G. C. Smith, K. E. Hoke and Z. L. Carpenter. Short-Term Transoceanic Shipments of Fresh Beef. Jour. Food Sci. 42:321-325. 1977.

Marriott, N. G., G. C. Smith, Z. L. Carpenter and K. E. Hoke. Intermediate-Term Transoceanic Shipments of Fresh Beef. Jour. Food Protect. 40:364-368. 1977.

McClure, W. F., K. H. Norris and W. W. Weeks. Rapid Spectrophotometric Analysis of the Chemical Composition of Tobacco. Part 1: Total Reducing Sugars. Beitrage zur Tabakforschung 9(1):13-18. 1977.

Moleeratanond, W., A. Kramer, B. H. Ashby, W. A. Bailey, and A. H. Bennett. Effect of Temperature Fluctuations on Energy Consumption and Quality Changes of Palletized Foods in Frozen Storage. Proc. Internatl. Union of Food Sci. and Technol., Karlsruhe, Germany. 1977.

Mongelli, Robert C., J. P. Anthony, Jr., M. D. Volz. Evaluating Two Systems of Harvesting and Handling Fresh Tomatoes. ARS-NE-94.

Mongelli, R. C. Selected Labor Requirements and Costs of Two Ice Cream Delivery Systems. ARS-NE-99.

Overheim, R. K., J. N. Morris, Jr., C. E. Harris, H. R. Smalley and C. F. Stewart. Food Distribution Facilities for Asheville, North Carolina. MRR 1069, June 1977. 57 pp.

Smith, G. C., Z. L. Carpenter, and K. E. Hoke. Modified Gaseous Atmospheres for Transoceanic Meat Shipments. Proc. 2nd. Natl. Controlled Atmos. Res. Conf., Mich. State Univ., East Lansing, Mich. p.45-51. 1977.

Watada, Alley E. and Karl H. Norris. Quality of Fresh Commodities Estimated by Spectrophotometric Technique. In Encyclopedia of Food Science (Encyclopedia of Food Technology and Food Science Series - Vol. 3), Peterson and Johnson, AVI Publ. Co., Westport, Conn., pp.648-653. 1978.

#### Yakima, Washington

Fountain, J. B., R. M. Hovey and T. M. Hinsch. Film Overwrapping of Apple Trays Increases Handling Efficiency. MRR 1076. 1978.

Yost, G. E., R. M. Hovey and H. M. Couey. Cooling Characteristics of Anjou Pears in Film-Overwrapped Trays. Trans. ASAE:20:1:198-200. 1977.



Cline, J. L. Efforts to Improve Food Marketing in the City. Jour. of Food Distribution Research, Vol. 9, No. 1, pp. 107-108.

Finney, E. E., Jr. Book review: Rheology and Texture in Food Quality. J. M. DeMan, P. W. Voisey, V. F. Rasper, and D. W. Stanley (ed.) AVI Publ. Co., Westport, Conn. (1976). Canadian Inst. Food Sci. and Technol. Jour. 10(2):A36-37. 1977.

Finney, E. E., Jr. Engineering Techniques for Nondestructive Quality Evaluation of Agricultural Products. Jour. Food Protection 41(1):57-62. 1978.

Finney, E. E., Jr. and Karl H. Norris. X-ray Scans for Detecting Hollow Heart in Potatoes. Amer. Potato Jour. 55:95-105. 1978.

Fleming, Bill. Project Shipping Fever. Beef Magazine, Vol. 13, No. 5, Jan. 1977, pp. 57-64.

Freshwater, J. F. An Overview of Food Service Productivity Research. Proceedings MTM Association Fall Conference, Oct. 1977, 14 pp.

Hoke, K. E. Commodity Requirements and Recommendations for Transport and Storage-Fresh Meats. Proc. 2nd Natl. Controlled Atmos. Res. Conf., Mich. State Univ., East Lansing, Mich. pp. 300-301. 1977.

Hoke, K. E. Effects of Modified Atmospheres on Meat During Storage and Long-Distance Transit. Proc. 2nd Natl. Controlled Atmos. Res. Conf., Mich. State Univ., East Lansing, Mich. pp. 294-299. 1977.

Hunt, W. H., D. W. Fulk, B. Elder, and K. Norris. Collaborative Study on Infrared Reflectance Devices for Determination of Protein in Hard Red Winter Wheat, and for Protein and Oil in Soybeans. Cereal Foods World 22(10):534-536. 1977.

Jen, Joseph J., Karl H. Norris and Alley E. Watada. In Vivo Measurement of Phytochrome in Tomato Fruit. Plant Physiol. 59:628-629. 1977.

Kaffka, K. J. and K. H. Norris. Rapid Instrumental Analysis of Composition of wine. Acta Alimentaria 5(3):267-279. 1976.

Karitas, J. J. Costs of Delivering Groceries and Frozen Foods to Restaurants in Combined or Separate Loads. MRR 1060. 28 pp.

Karitas, J. J. Costs of Delivering Groceries and Frozen Foods to Restaurants in Combined or Separate Loads. Jour. Food Distribution Res., Vol. 8, No. 1, p. 101. 1977.

Karitas, J. J. Cost Comparison of Five Institutional Food Delivery Systems. MRR 1092.

Lederer, B. E. Shell Egg Damage from End of Packing Line to Supermarket. ARS-NE-93.

ANNUAL REPORT  
FY 1977

National Research Program 20620

INSECT CONTROL IN MARKETING

The major objective of this National Research Program is to reduce losses caused by insects to harvested agricultural commodities and their processed or manufactured products throughout the entire marketing channels and until they reach the final consumer. The research is basic, applied, and developmental in nature and uses teamwork among several scientific disciplines.

NPS Contact: L. S. Henderson

PACS Contact: M. T. Ouye

Technological Objective 1:

Develop new and improved technologies for reducing losses to insects in agricultural commodities and their products in the marketing channels.

Research Locations:

Fresno, California  
Gainesville, Florida  
Savannah, Georgia  
Manhattan, Kansas  
Beaumont, Texas  
Richmond, Virginia  
Madison, Wisconsin

Selected Examples of Recent Progress:

Basic biological research:

Navel orangeworm sex pheromone - Gainesville, FL. Synthesis has been completed for two of the four possible isomers. Both compounds stimulated male activity but much less than the natural pheromone. Studies indicated that the major pheromone component is one of the two isomers not yet synthesized.

Effect of feeding or oviposition stimuli on the sweet potato weevil - Gainesville, FL. The presence of both feeding and oviposition stimuli in the skin or periderm of the sweet potato was confirmed. The oviposition rate was about 50 times as great in sweet potatoes with the skin on them as in those with the skin removed. It was also found that feeding was required for both follicle development and vitellogenesis. Feeding did not stimulate oviposition in unmated females.

Behavior of red flour beetles - Gainesville, FL. When food was in widely scattered small piles as might be encountered in an empty warehouse with

poor sanitation, red flour beetles moved freely between the piles and placed eggs in them. With 25 piles and 50 females in a room 7x7x2.6m nearly all piles had eggs after 24 hours and 30% contained eggs but no females. About 50% of the beetles were in food piles, 10% were crawling around, and 40% were in cracks between floor tiles. Beetles escaped from the room at the rate of 25% per day. When floor cracks were eliminated and food density increased, as many as 90% of the beetles were in food piles. Studies on survival and fecundity at several feeding rates demonstrated that these beetles are well adapted to utilizing a dispersed food supply.

Sex pheromone produced by male Indian meal moths - Gainesville, FL. A quantitative bioassay was developed to observe and measure the response of female Indian meal moths to the male pheromone. Females will display typical sexual response in the presence of extracts from male wing glands. Males did not exhibit any marked rhythm of pheromone production, although extracts made in the late afternoon appeared to produce the most consistent female response.

Cytoplasmic incompatibility - Savannah, GA. Males of a reproductively incompatible strain of the almond moth, Ephestia cautella (Walker), were added to males and virgin females of another strain at various male ratios of 1:1 to 24:1. Percentage of egg hatch was 43.4% at the 1:1 ratio and only 8.1% at the 24:1 ratio, while the total number of progeny per female decreased from an average of 36.1 to 2.1. Calculated competitiveness values showed that the normal females showed no mating preference between strains, therefore release of large numbers of incompatible males should lead to population suppression.

Prolonging activity of insect pheromones - Savannah, GA. A UV inhibitor mixed with insect pheromones prevents their breakdown in sunlight. This extends the effectiveness of the pheromones used in field traps from a few days to a few months. A patent application is in progress.

Important insect hormones identified - Manhattan, KS. Several peptides in insects have been discovered that closely resemble vertebrate peptide hormones, both immunologically and in their physiological effects. These compounds include insulin, glucagon, and gastrin. These observations are significant for insect endocrinology, and they are also of fundamental importance to the evolutionary history and functional roles of peptide hormones throughout the animal kingdom. Insects have been controlled in laboratory tests using chemicals that mimic or oppose the action of these hormones.

Host resistance - Manhattan, KS. Significant differences in resistance to rice weevil were found among hard winter wheats grown at different locations. The presence of barley hulls definitely reduced the oviposition of rice weevils. Barley varieties varying in protein content and grown at three different locations showed wide differences in levels of rice weevil progeny production. Blue-aleurone-layered barleys as a group produced slightly fewer progeny than did the white-aleurone-layered barleys.



Resistant rice varieties - Beaumont, TX. Since 1972 a considerable amount of effort has been devoted to a search for rice varieties that resist attack by storage insects. Several varieties have been found that consistently resist penetration by the Angoumois grain moth, several that inhibit growth of red flour beetle larvae, and a few that do both. There is strong evidence that one type of resistance is heritable. If the resistant characters can be identified as usable in commercial varieties and incorporated therein, this would be a significant advance in reducing losses to storage insects worldwide. Cooperative efforts with rice breeders are underway to further develop this research.

Temperature and insect oviposition - Richmond, VA. Most insects oviposit only when environmental conditions are highly favorable for development of their progeny. The cigarette beetle is not a cold-hardy insect and the larval stage prefers a temperature of 24°-28°C for development. It was astonishing, therefore, to find that the females would oviposit readily over a broad temperature range of 15°-40°C. This indicates that commodities may become infested at higher and lower temperatures than formerly expected.

Oviposition attractants - Richmond, VA. Oviposition response of cigarette beetles to ethanol extracts of different products was observed. The beetles were reared on the standard laboratory diet of whole wheat flour plus 5% yeast. The response was as follows: yeast - 29%, CSM (cornmeal - soybean flour, and nonfat dry milk) - 22%, citrus pulp - 21%, whole wheat flour - 10%, a mixture (tobacco, CSM, whole wheat flour, yeast, and citrus pulp) - 7%, muslin cloth - 5%, tobacco - 5%, and medium from a dead culture - 1%. A different response might be anticipated from beetles reared on tobacco and that will be determined.

Sex pheromones - Madison, WI. The sex pheromone produced by the female drugstore beetle has been isolated and identified. The major sex pheromone from the female of Trogoderma simplex was also identified. It is the same or similar to that previously identified from several Eurasian Trogoderma. In contrast, the sex pheromone isolated from females of T. sternale, T. ornatum, and T. anthrenoides appears to be much different from that obtained from other Trogoderma species.

Lesser grain borer pheromones - Madison, WI. Studies reveal that lesser grain borer males emit two pheromones that attract both males and females. The compounds have been isolated, identified, and synthesized. They are highly effective in aggregating both sexes and have significant potential in detection and suppression programs for the lesser grain borer. This is the first species in the family Bostrichidae from which pheromones have been identified.

Food attractants - Madison, WI. Studies of vegetable oils and Trogoderma glabrum larvae showed that wheat germ oil was highly attractive. Other oils in decreasing order of larval aggregation were: peanut, soybean, corn, safflower, linseed, sesame, sunflower, and cottonseed. A striking

cyclic variation in the aggregation response of T. glabrum larvae to wheat germ oil was observed, perfectly matching the molting cycle. The response is highest in freshly molted larvae and reaches a minimum just prior to molting. The largest weight gain immediately follows the maximum response. There is a general lethargy in starved larvae, contributing to a fast decline in response. There is a dramatic increase in response immediately after a retrogressive molt.

#### Biological control agents:

A nematode for use against the navel orangeworm - Fresno, CA. Preliminary tests with Neoplectana carpocapsae in almond orchards gave promising results. Three spray applications reduced adult and larval populations 60%. Kernel damage by larvae was reduced 34%. Laboratory studies with anionic starch derivatives, developed by SEA-FR chemists, as an additive for the nematode spray suspension increased the viscosity. This caused more suspension to adhere to the almonds and permitted the nematodes to remain mobile for a longer period of time. This could increase the efficacy of field applications.

Granulosis virus on raisins - Fresno, CA. Laboratory data show that the virus can be an effective protectant against larvae of the Indian meal moth on stored raisins. Infestation was reduced as much as 95% in field-run raisins stored 14 weeks after they were sprayed with a virus suspension.

Another predator found - Savannah, GA. A hemipterous predator, Dufouriellus ater (Dufour), was collected in bins of farmers stock peanuts at the Savannah Laboratory. The peanuts were infested with numerous species of stored-product beetles and with the almond moth and Indian meal moth. In the laboratory it preys readily and develops well on eggs and early-stage larvae of stored-product moths, but fecundity has been low and it has not yet been possible to rear the insect in large numbers.

Bacillus thuringiensis for moth control in stored grains - Manhattan, KS. Preliminary results of pilot tests in 2.1 m<sup>3</sup> bins of wheat and corn showed that treatment of the surface layer of the grain with a formulation of B. thuringiensis would protect against Indian meal moth and almond moth infestations. During the first season after treatment moth populations in artificially infested bins were 81 to 98% lower than in untreated bins, and insect-damaged kernels in the surface layer were 82 to 96% fewer. This treatment appears to be an effective alternative for the chemical insecticides to which these moths have become resistant, and will be the first use of a micro-organism for controlling insects in stored grain. There has been granted an exemption from the need for a tolerance for residues on all raw agricultural commodities for postharvest application. An experimental label has been issued for use on stored grain.

#### Physical control methods:

Controlled atmospheres for almonds and raisins - Fresno, CA. In a test



on binned almonds an atmosphere of 0.5% or less of O<sub>2</sub>, 9-11% of CO<sub>2</sub>, and the remainder N<sub>2</sub> was produced. There was 100% mortality of red flour beetle and merchant grain beetle in 54 hours, of Indian meal moth in 76 hours. The temperature was 80°F. In small stocks of field-run raisins there was 100% mortality of all three of the above species in 94 hours.

Hidden-insect detection - Savannah, GA. The detection system developed at and patented by the Savannah Laboratory is now undergoing field testing by the Federal Grain Inspection Service to determine the feasibility of incorporating the CO<sub>2</sub> detection method into their inspection procedures. The system is also being evaluated by the Department of Defense to determine how it may fit into their inspection and surveillance of subsistence items. Technicon Instrument Company, Inc., the licensee of the patent, has now produced its first commercial model. This instrumentation provides government action agencies and U.S. agribusiness a rapid and effective method for detecting insect infestation in raw or processed foods and feeds. The system is nondestructive so samples are available for further analysis and subsequent warranty or legal actions.

Controlled atmosphere for cowpea weevil - Manhattan, KS. Various stages of the cowpea weevil, Callosobruchus maculatus (Fabricius) were exposed to low-oxygen atmospheres produced by an exothermic gas burner. Exposure times at 27°C for 100% mortality were 48 hours for adults, 96 hours for 1- and 3-day old eggs, 120 hours for 7- and 14-day old larvae, and 192 hours for 21-day old larvae and pupae.

Protective liners in tobacco cases - Richmond, VA. Flue-cured tobacco is being packed in corrugated fiberboard cases holding about 500 lbs. of tobacco. Tests have been underway to determine the value of a case liner of spun-bonded polyethylene, 1.3 oz./yd.<sup>2</sup>, to protect the tobacco against cigarette beetle infestation and damage. In two different tests the tobacco has been stored for 1½ and 2 years without any insect damage, and without any insect penetration holes in the liners. In 2 years the tobacco did not change in alkaloid or sugar content. In a 2-year test of cases with an asphalt-laminated paper liner there were a few holes in the liners and slight damage to the tobacco.

#### Conventional chemical control:

Fumigating bagged foods - Savannah, GA. Tests were conducted in India to determine whether 1,000-cu.ft. stacks of bagged food products could be fumigated under polyethylene tarpaulins. The 50-lb. bags were of woven propylene or of multiwall paper with polyethylene liners. The fumigants applied were 2 lbs. of methyl bromide or 45 aluminum phosphide tablets. Phosphine gas produced by the tablets readily penetrated both types of bags but aerated more slowly out of the polyethylene-lined paper bags. Some test insects survived in the paper bags fumigated with methyl bromide, indicating that a larger dosage should have been used to obtain complete kill.



Preliminary evaluation of new insecticides - Savannah, GA. Of 21 new compounds evaluated, only Shell SD43775 (AI3-29235) and NRDC-161 (AI3-29279) were promising enough for further testing as direct-contact and residual insecticides.

Evaluation of candidate repellents - Savannah, GA. Of 170 compounds evaluated as repellents against confused flour beetle adults, 41 received from the SEA-FR Organic Chemicals Synthesis Laboratory were rated as equal to or more repellent than the synergized pyrethrins standard. The four showing the greatest potential for further evaluation were AI3-32829, -32856, -35975, and -36250. Four of 14 plant extracts received from the SEA-FR Western Regional Research Laboratory were more effective than the standard repellent. One identified as Regional No. 2714 showed a high potential for further evaluation. Three of 18 seed extracts received from the Northern Regional Research Center were equal to the standard. They were from Malva aegyptia (Malvaceae), Tragia incana (Euphorbiaceae), and Zanthoxylum acanthopium (Rutaceae).

Further evaluation of permethrin - Savannah, GA. When tested again six common species of stored-product insects, permethrin was much more effective than malathion against the larval stages but much less effective against the adults. In cooperative tests with the Western Regional Research Laboratory it was found that permethrin could be applied to wool fabric as a mothproofing treatment in the hot dye bath and was compatible with a wide range of dye types. It was also shown to be compatible with the tetrabromophthalic anhydride flame resistance treatment and with two shrink-proofing treatments based on ozone and polyurea.

Further evaluation of fenitrothion - Savannah, GA. In tests against six common species of stored-product insects, fenitrothion was more effective than malathion against all of them. As a protective treatment for wheat or corn it was more effective than malathion against rice weevils after 1 year of aging.

In-transit shipboard fumigation - Savannah, GA. Research on application and procedures for in-transit fumigation of U.S. export grain in ships' holds has resulted in two revisions of FGIS GR Instruction 918-6, Aux. 19. This provides procedures that are designed to be effective as well as safe for crew, longshoremen, and FGIS inspectors.

Tests were conducted on a shipload of wheat bound for Chile, S.A. Six holds were fumigated with aluminum phosphide tablets at 50 per 1,000 cu.ft., using a layering technique of applying one-third the dosage at three levels as the holds were filled with wheat. The holds were sealed for 7½ days transit then opened for aeration. Good gas distribution was obtained during fumigation and no live insects were found. One hold was treated by stepping the tablets under the grain surface after the hold was filled. This hold was kept sealed for 10½ days, then opened for aeration. Gas concentrations were low and insects survived at about 12 meters below the deck and at the bottom of the hold.

Corn was fumigated in transit aboard a bulk cargo ship from Norfolk, VA., to Ghent, Belgium. Two holds were fumigated by putting bags of granular aluminum phosphide on the surface of the grain. Phosphine gas reached the bottoms of the holds in 6 to 8 days, the holds being 20 meters deep. All insects were killed during the 21 days of exposure. Two holds were fumigated with the 80:20 mixture of carbon tetrachloride and carbon disulfide. The fumigant reached the bottoms of the holds within 6 hours, but some insects survived the fumigation on the surface of the corn in the hold. No fumigant vapors were found in the working areas of the ship during the voyage. No phosphine gas was detected above the grain surface during unloading, but low concentrations of carbon tetrachloride and carbon disulfide were measured.

Tolerance of head lettuce to fumigants - Savannah, GA. A vacuum of 260 mm of mercury reduced damage to lettuce exposed to low levels of phosphine for up to 14 days. A combination of nitrogen and vacuum maintained quality when 600-800 p.p.m. of phosphine were present for 48 hours. Up to 8 mg./liter of methyl bromide did not damage lettuce during a 6-hour exposure regardless of atmospheric pressure. A 1:9 mixture of ethylene oxide and carbon dioxide at up to 5 mg./liter of ethylene oxide did not damage lettuce exposed for 24 hours at atmospheric pressure or 260 mm. of mercury.

Evaluation of new fumigants - Savannah, GA. A Pennwalt Corp. compound TD-5032 (AI-27428) was found to be more than 600 times as toxic as methyl bromide to adult confused flour beetles as a space fumigant. The LD50 for the new compound is between 0.0039 and 0.0046 mg./liter, which compares with 3.17 mg./liter for methyl bromide under identical conditions. The compound produced rapid knockdown but it was often several days before the insects died. Much more remains to be learned about this interesting compound.

New peanut protectant - Savannah, GA. Research data developed by SEA/FR scientists have been provided to the manufacturer as an aid to obtaining registration for pirimiphos-methyl as a protectant for farmers stock peanuts. Insects have become highly resistant to malathion, which has been the standard peanut protectant for several years. Pirimiphos-methyl is effective against malathion-resistant strains of insects, can be applied at about one-third the rate required for malathion, and the mammalian toxicity is less than that of malathion. A request will also be made for its registration as a residual insecticide for use in peanut warehouses.

Field tests were conducted in cooperation with the National Peanut Research Laboratory in Dawson, GA., to determine the effects of forced aeration during storage on the residual persistence and biological efficacy of pirimiphos-methyl as a peanut protectant. The peanuts were treated with 20 p.p.m. as the 10-ton capacity bins were filled. An airflow rate of 0.1 c.f.m./bu. was used to push air up through two bins and to pull air down through two others, while two bins had no aeration. After 6 months, the insects had been controlled in all bins. The residues were higher on the peanuts in the aerated bins, probably because the aeration maintained better storage conditions.



Evaluation of residual sprays - Savannah, GA. A slow-release pirimiphos-methyl formulation applied as a water-base spray at 100 micrograms/cm.<sup>2</sup> was still effective on most test surfaces, including concrete, 66 weeks after treatment. Most insecticides lose effectiveness on concrete surfaces within 1 or 2 weeks. Two pyrethroid compounds, permethrin and SD-43775 were effective on galvanized metal for 66 weeks but not for that long on any of the other test surfaces.

Insecticidal space treatment, Savannah, GA. Pirimiphos-methyl was applied at 0.5 gram per 1,000 cu.ft. at 3-week intervals with a large ultra-low-volume dispenser. The unit was positioned in the center aisle near one end of a 1.25-million cu.ft. warehouse. Distribution and efficacy were as good as or better than with dichlorvos applied weekly at 1 gram per 1,000 cu.ft. Air samples the morning after treatment, taken from several locations in the warehouse, showed little or no pirimiphos-methyl in the air. Chemical analyses are being conducted to determine residues in commodities from the warehouse.

Toxicants from natural plant products - Savannah, GA. Acetone extract of black pepper was cleaned up and fractionated in chromatographic columns. In addition to piperine, five other fractions were obtained that were moderately or highly toxic to rice weevils and cowpea weevils. A total of 40 spices and herbs were pulverized or prepared as acetone extracts for testing against rice weevils, cowpea weevils, or cigarette beetles. The following gave enough indication of toxic effect to be of interest for further evaluation:

Rice weevil - dill seed, mace, nutmeg, sesame seed, and clove.

Cowpea weevil - dill seed, mace, nutmeg, clove, coriander seed, tarragon, and horseradish.

Cigarette beetle - dill seed, parsley, bay, marjoram, mint, onion, garlic, tarragon, and horseradish.

Grain protectants - Manhattan, KS. Pirimiphos-methyl is indicated to be a highly effective protectant on the basis of high mortality and low reproduction of five species of stored-grain insects tested, along with a low degradation rate on corn, wheat, and grain sorghum. Studies with chlorpyrifos-methyl on wheat indicate it may also be an effective protectant, but the deposit degrades more rapidly than with pirimiphos-methyl.

Insect resistance to malathion - Beaumont, TX. Twenty-eight strains of four species of stored-grain insects have been collected at commercial rice operations in Texas. Bioassays with malathion-treated grain show that resistance is widespread and in some cases severe. Most strains of the red flour beetle, lesser grain borer, and Angoumois grain moth were found to be resistant, some to the point of immunity. No resistant strains of the rice weevil were found.



Fumigant distribution in vacuum - Richmond, VA. Concentration of ethylene oxide in tobacco packed in hogsheads was increased by drawing the fumigant from the free space of the vacuum chamber to the center of the hogshead by connecting the vacuum system of the chamber to a perforated probe located in the center of the hogshead. With the probe, distribution of the ethylene oxide through the tobacco in the hogshead was nearly uniform and cigarette beetle larvae were killed by a 4-hour exposure at 26°C with a dosage of 1.8 kg/28.3m<sup>3</sup>. Without a probe, gas concentration in the tobacco at depths of 30 cm or more was less than 3 mg/liter, and planted test insects survived. Ethylene oxide was less effective at temperatures of 7.8°-20°C.

Developing integrated pest management systems:

Almond moth in stored peanuts - Gainesville, FL. Suction trap catches indicated that every 4 weeks the almond moth population increased twofold in an empty commercial seed peanut warehouse and 37-fold in a stocked warehouse. Combining a green- or black-light lamp with the suction trap increased the number of almond moths captured. This was attributed to an associated increase in flight activity rather than attraction by the lamps. As parasite-paralyzed almond moth larvae are aged, the number remaining moist and suitable to Bracon hebetor adult wasp feeding, oviposition, and development of offspring declines 15% per week. This gives parasites a considerable amount of time to locate paralyzed hosts. Field tests have shown that simultaneous releases of parasites and parasite-paralyzed host larvae more effectively suppresses almond moth infestation than does the release of parasites alone.

Pheromone traps for moths - Gainesville, FL. Eight pheromone trap designs were tested for effectiveness in capturing Indian meal moths and Angoumois grain moths. A wing trap gave the best results with the Indian meal moth and was among the best three for the Angoumois grain moth. Volatilization of the pheromones of both species from the same trap had no effect on the capture of Indian meal moths but the presence of the pheromone of the Indian meal moth reduced catches of the Angoumois grain moth. The presence of competing sexually receptive females did not reduce the effectiveness of the pheromone-baited traps. The pheromone release rates were determined by gas chromatography for the different dispensers used in the trapping studies.

Insect detection and suppression - Madison, WI. Wind tunnel bioassay procedures were utilized in determining release rates of pheromone from T. glabrum females. The knowledge of release rate has been used to improve the system of infecting insect populations from a spore-transfer site containing pathogens and attractants.

Research on pheromones, larval attractants, and traps has resulted in effective trapping techniques for dermestid beetles and cockroaches and is especially promising for the khapra beetle. The materials and procedures are being evaluated with several cooperators, including APHIS in port facilities.

Horticultural crops:

Protectant for almonds - Fresno, CA. An experimental compound, Dowco-214<sup>®</sup>, gave excellent protection for 12 months to in-shell almonds against infestation by five species of stored-product insects. The treatment was applied at the rate of 8 ppm and had no adverse effect on flavor, odor, or appearance of the almonds.

Navel orangeworm control - Fresno, CA. Almond growers with small groves of 20 to 40 acres have believed they would not benefit by spending money for insect control if they were surrounded by neighbors who did not practice insect-control measures. Research during the last 3 years has refuted this idea. It has been possible to bring about at least a 50% reduction in navel orangeworm damage by carrying out orchard sanitation or sanitation plus carbaryl applications, both combined with timely, early harvest. Savings for these small growers have been as much as \$550 per acre.

Stack covers for almonds - Fresno, CA. Temperature build-up is excessive when stacks of inshell almonds are covered with some kinds of films to retain fumigant gas and protect the commodity. A study was conducted with seven different materials to find one that would cause a minimum temperature increase. One of the best was a 5-mil white polyethylene film that is readily available at a reasonable cost.

Fumigation manual prepared - Fresno, CA. Research experience was drawn upon to prepare a manual as a guide to the fumigation with phosphine of inshell almonds on the farm. This is for the use of growers, pest control operators, or others who may need it.

Infestation of spices - Savannah, GA. The cigarette beetle infested 14 different kinds of spices, but not cinnamon, cloves, East Indian mace, or nutmeg. Fifty percent of the adults emerged within 70 days on paprika, 71 days on cayenne pepper, 122 days on curry powder, and 135 days on chili powder.

Field crops and their processed products:

Coastal Bermuda grass feed pellets - Savannah, GA. The red flour beetle, the merchant grain beetle, and the almond moth lived only a few days with the feed pellets as their only food supply. The cigarette beetle lived longer, but none of the species caused any appreciable damage to the pellets.

Stored-product pests in foreign countries - Savannah, GA. Twenty-three species of insects were collected from storage areas in nine countries. The most common species were the red flour beetle, rice moth, and almond moth. These, along with the lesser grain borer and the cigarette beetle caused the most damage. The latter two species chew holes through packaging materials, thus making an opening through which other species can gain entry to packaged foods.

Insects and fungi in export grain - Manhattan, KS. In cooperation with the Federal Grain Inspection Service, subsamples of official grade samples of export wheat and corn are sent to the laboratory for incubation. In results thus far samples containing one or more live insects ranged from 15 to 32% of those from elevators on the Great Lakes, East Coast, and Gulf Coast. Insects were found in less than 10% of the samples from the West Coast. The predominant species have been Sitophilus and Cryptoleptes.

Corn samples had an average of 30% of the kernels internally invaded by Aspergillus glaucus and 2% by A. flavus. Wheat samples had 0 to 5% invasion by A. glaucus and other storage fungi.

Fumigation of export hay - Manhattan, KS. Fumigation tests were conducted in Seattle, Washington, in 40-ft. shipping containers loaded with standard and compressed bales of timothy hay containing the "flaxseed" or pupal stage of the Hessian fly. A proposed treatment schedule was established for phosphine fumigation to submit for consideration by the Japanese government Plant Pest Control officials, so the hay can be exported to Japan.

Biorational chemical control of stored-grain insects - Manhattan, KS. Five pyridyl or phenyl ether analogues of juvenile hormone were tested for activity against eight species of stored-grain insects. They were evaluated for ability to prevent larval development from eggs, suppress progeny, or cause mortality. Some were highly promising in their activity against several species. Studies are continuing to develop further detailed information.

#### Insect control in structures and facilities:

Aerosol application in wineries - Fresno, CA. Aerosols containing 0.25% of resmethrin, 0.175% of d-trans allethrin, or 0.015% of RU 15-525 were applied experimentally in wineries for vinegar fly control. All these synthetic pyrethroids gave as good results as did natural pyrethrins at 0.25%.

#### Technological Objective 2:

Develop new and improved technologies for quarantine treatments to destroy pests.

#### Research Locations:

Fresno, California  
Miami, Florida  
Honolulu, Hawaii  
Hilo, Hawaii



Selected Examples of Recent Progress:

Tolerance of fruits and vegetables to fumigants - Fresno, CA. A number of varieties of different fruits and vegetables have been tested for tolerance to fumigation with methyl bromide or ethylene dibromide at different dosages, temperatures, and exposure times. Without including details, the general or gross results are as follows:

1. Lemons. Indications are that Eureka and Lisbon varieties may be tolerant to normal treatment with ethylene dibromide or methyl bromide.
2. Avocados. The Zutano variety was not tolerant to methyl bromide. Fuerte, Hass, Susan, and Bacon varieties were tolerant or borderline, further details to be developed.
3. Strawberries. Tioga and Heidi varieties tolerant to methyl bromide.
4. Tomatoes. Ace variety tolerant to methyl bromide, but there was a 2-3 day delay in ripening.
5. Bell peppers. Several fumigations have been conducted with methyl bromide. Tolerance is borderline, data are inconclusive, and further work is necessary.
6. Canteloupes and watermelons. Screening tests indicate probable tolerance to methyl bromide but these are very preliminary results.
7. Sweet cherries. Bing variety was tolerant to methyl bromide.
8. Citrus. Four California varieties of citrus have been fumigated with ethylene dibromide and methyl bromide. The studies are still very preliminary.

Tests with phosphine - Miami, FL. Phosphine from Fumi-Cels containing magnesium phosphide was tested on eggs and larvae of the Caribbean fruit fly in grapefruit. A total of 2,520 fruit containing 12,360 insects was fumigated under tarpaulins for 48 hours with 1.17 mg/l. There was survival of 266 insects in only two of the tests in which overnight temperatures dropped to 7°C. The total mortality was 98%. Using the same dosage rate but extending the fumigation period to 72 hours gave 100% mortality of 20,450 insects in 1,728 grapefruit.

Ten 72-hour fumigations were conducted in a small (22.28m<sup>3</sup>) refrigerated semi-trailer, at 13°C, using a fumigant rate of 1.48 mg/l. A total of 6,444 grapefruit containing 82,736 insects was fumigated, with only one survivor, for a mortality rate of 99.999%.

Tests with methyl bromide - Miami, FL. A total of 120 fumigations was conducted over a period of 15 months in an  $0.8\text{m}^3$  fumigation chamber, using methyl bromide against eggs and larvae of the Caribbean fruit fly in grapefruit. The fumigation period was 2 hours, with continuous air circulation, at temperatures of  $21^\circ\text{C}$  or more. The tests used about 20,000 "Marsh" seedless grapefruit made available through the cooperation of the Florida Citrus Commission. Methyl bromide dosage rates were  $40\text{mg/l}$  for a 20% chamber load and  $56\text{mg/l}$  for an 80% load. There were no survivors from more than 240,000 test insects. A computer program for predicting probit 9 security (99.9968% mortality) indicated a dosage of  $45.6\text{mg/l}$  for a 20% load and a dosage of  $44.3\text{mg/l}$  for an 80% load. Tests were also conducted in a  $60\text{m}^3$  semi-trailer van enclosed in a  $270\text{m}^3$  fumigation chamber. There were no survivors from 15,569 insects in 1,464 grapefruit. These tests give evidence of biological efficacy, but further information is needed on whether the treatment will adversely affect fruit quality, and whether the results of the experimental situation can be reproduced under commercial conditions.

Experimental fumigants - Miami, FL. Sixteen experimental compounds were tested against immature stages of the Caribbean fruit fly in grapefruit. None was promising in performance.

Tolerance of tomatoes to fumigants - Miami, FL. Walter and Flora-Dade tomato varieties were not damaged by methyl bromide at normal dosage levels. Walter tomatoes were damaged by EDB at a minimal dosage of  $8\text{mg/l}$  for 2 hours. Walter and Flora-Dade tomatoes were not injured by phosphine during 4-day exposures at  $15^\circ\text{C}$  and gas concentrations of 250 to 350 p.p.m. Flora-Dade variety was severely damaged when gas concentrations were 1200 to 1700 p.p.m. and the temperature was  $24^\circ\text{C}$ .

Potential quarantine treatment for papayas - Honolulu, HI. A tentative schedule was developed for the oriental fruit fly in papayas, using a combination of hot water dip and phosphine fumigation.

Microwave treatment - Honolulu, HI. A 10-minute exposure to microwave at  $2450\text{MH}_2$  killed some melon fly eggs but in some cases allowed up to 30% survival. Studies with fruit fly-infested Bing cherries, lemons, oranges, plums, summer squashes, tangerines, tomatoes, and zucchini squashes indicated that the method was not promising as a quarantine treatment because of injury to the commodities.

Host status of pineapple varieties - Honolulu, HI. Two new pineapple varieties, D-10 and D-20, were shown not to be hosts of tropical fruit flies. APHIS has been petitioned to permit entry of these two, along with the standard variety Smooth Cayenne, into the U.S. mainland without quarantine treatment for fruit flies.

Hot-water dip for bananas - Honolulu, HI. A 30-minute  $50^\circ\text{C}$  hot-water dip was developed as an effective treatment against fruit flies in apple variety bananas. The treatment did not injure the fruit and added 14 to 36 hours to shelf life. APHIS has been petitioned to accept this for their treatment manual.

PUBLICATIONS

Fresno, California

- Hunter, D. K., S. S. Collier, and D. F. Hoffman. Granulosis virus of the Indian meal moth as a protectant for stored inshell almonds. J. Econ. Entomol. 70:493-494. 1977.
- Kellen, W. R., D. F. Hoffmann, and S. S. Collier. Studies on the biology and ultrastructure of Nosema transitellae sp.n. (Microsporidia: Nosematidae) in the navel orangeworm, Paramyelois transitella (Lepidoptera: Pyralidae). J. Invertebr. Pathol. 29:289-296. 1977.
- Kellen, W. R., D. K. Hunter, J. E. Lindegren, D. F. Hoffmann, and S. S. Collier. Field evaluation of Bacillus thuringiensis for control of navel orangeworms on almonds. J. Econ. Entomol. 70:332-334. 1977.
- Soderstrom, E. L. Seal of almond shells and resistance to navel orangeworm. J. Econ. Entomol. 70(4):467-468. 1977.
- Yerington, A. P. Three synthetic pyrethroids for control of Drosophila spp. in wine cellars. J. Econ. Entomol. 70(4):495-496. 1977.

Gainesville, Florida

- Dutkowski, A. B., H. Oberlander, and C. E. Leach. Ultrastructural studies on cuticle deposition in insect wing disks. In Viklicky, V. and J. Ludnik, eds. Proceedings of the XVth Czechoslovak Conference on Electron Microscopy with International Participation, Prague, Aug. 22-26, 1977.
- Dutkowski, A. B., H. Oberlander, and C. E. Leach. Ultrastructure of cuticle deposited in Plodia interpunctella wing discs after various B-ecdysone treatments in vitro. Wilhelm Roux's Archives 183:155-164. 1977.
- Ferkovich, S. M., H. Oberlander, and R. R. Rutter. Release of a juvenile hormone binding protein by fat body of the Indian meal moth, Plodia interpunctella, in vitro. J. Insect Physiol. 23:297-302. 1977.
- Hagstrum, David W. and Burrell J. Smittle. Host-finding ability of Bracon hebetor and its influence upon adult parasite survival and fecundity. Environ. Entomol. 6(3):437-439. 1977.
- Hagstrum, D. W., J. M. Stanley, and K. W. Turner. Flight activity of Ephestia cautella as influenced by the intensity of ultraviolet or green radiation. J. Ga. Entomol. Soc. 12(3):231-236. 1977.
- Marzke, F. O., J. A. Coffelt, and D. O. Silhacek. Impairment of reproduction of the cigarette beetle, Lasioderma servicorne with the insect growth regulator, methoprene. Entomologia Exp. et Applicata 22. 1977.



Sower, Lonnie L. and G. Patrick Whitner. Population growth and mating success of Indian meal moths and almond moths in the presence of synthetic sex pheromone. Environ. Entomol. 6(1):17-20. 1977.

Miami, Florida

Burditt, A. K., Jr. and D. L. von Windeguth. Large chamber fumigation of grapefruit infested with the Caribbean fruit fly, Anastrepha suspensa (Loew). Proc. Fla. State Hort. Soc. 89:170-171. 1976.

Burditt, A. K., Jr. and D. L. von Windeguth. Concentrations of ethylene dibromide gas during fumigation of grapefruit. Proc. Fla. State Hort. Soc. 89:220-225. 1976.

von Windeguth, D. L., A. Arner, J. B. Owens, and A. K. Burditt, Jr. Comparison of natural field infestation vs laboratory infestability of 'Marsh' white grapefruit by Caribbean fruit fly Anastrepha suspensa (Loew). Proc. Fla. State Hort. Soc. 89:248-249. 1976.

Brueck, J. H., III and A. K. Burditt, Jr. Toxicity of ethylene dibromide to eggs and larvae of the Caribbean fruit fly, Anastrepha suspensa (Loew). Fla. Entomologist, 60(3):211-215. 1977.

Savannah, Georgia

Arbogast, R. T., G. L. LeCato, and M. Carthon. Longevity of fed and starved Xylocoris flavipes (Reuter) (Hemiptera: Anthocoridae) under laboratory conditions. J. Ga. Entomol. Soc. 12:58-64. 1977.

Baker, J. E. Factors affecting pupation of starved larvae of the black carpet beetle, Attagenus megatoma. J. Ga. Entomol. Soc. 12:268-272. 1977.

Baker, J. E. Growth and development of the black carpet beetle on the laboratory diet. Ann. Entomol. Soc. Am. 70:296-298. 1977.

Baker, J. E. Substrate specificity in the control of digestive enzymes in larvae of the black carpet beetle. J. Insect Physiol. 23:249-253. 1977.

Baker, J. E. Synchronized pupation in starved and fed larvae of the black carpet beetle. Ann. Entomol. Soc. Am. 70:299-302. 1977.

Brower, J. H. Interspecific matings between stored-product Pyralidae (Phycitinae). J. Ga. Entomol. Soc. 12:215-220. 1977.

Bruce, W. A., and M. W. Street. A technique for monitoring living organisms. Proceedings of the XII International Conference of the International Society for Chronobiology. Washington, D.C., August 10-13, 1975. Pg. 627-629. 1977.

Bry, R. E., R. E. Boatright, J. H. Long, and R. A. Simonaitis. Long-term protection of woolen fabric with synergized pyrethrins. Pyrethrum Post 14:26-29. 1977.

- Bry, R. E., J. H. Long, R. E. Boatright, and R. A. Simonaitis. Durability of resmethrin on woolen cloth. *J. Ga. Entomol. Soc.* 12:173-179. 1977.
- Bry, R. E., R. A. Simonaitis, R. E. Boatright, and J. H. Long. Chlorpyrifos and ronnel: Effective protectants of rubberized hair cushioning material against larvae of the black carpet beetle. *J. Ga. Entomol. Soc.* 12: 347-350. 1977.
- Cline, L. D., and H. A. Highland. Penetration by adult lesser grain borers through multiwall kraft bags. *J. Econ. Entomol.* 70:156-158. 1977.
- Redlinger, L. M., and R. A. Simonaitis. Field tests with pirimiphos-methyl as a protectant for farmers stock peanuts. *Peanut Sci.* 4:27-31. 1977.
- Simonaitis, R. A., and R. S. Cail. Gas chromatographic determination of residues of the synthetic pyrethroid FMC 33297. In *Synthetic pyrethroids*, ACS Symposium Series, No. 42:211-223. 1977.
- Simonaitis, R. A., R. S. Cail, J. M. Zehner, and R. E. Bry. Gas-liquid chromatographic determination of m-phenoxybenzyl cis, trans-(+)-3-(2, 2-dichlorovinyl)-2, 2-dimethylcyclopropanecarboxylate in aqueous formulations. *J. Assoc. Off. Anal. Chem.* 60:9-13. 1977.
- Smithwick, E. B., and V. E. Brady. Histology of the sex pheromone gland in developing female Indian meal moths, Plodia interpunctella. *J. Ga. Entomol. Soc.* 12:13-29. 1977.
- Lum, P. T. M. High temperature: Inhibition of development of eupyrene sperm and reproduction in Plodia interpunctella and Ephestia cautella. *J. Ga. Entomol. Soc.* 12:199-203. 1977.
- McGovern, T. P., H. B. Gillenwater, and L. L. McDonald. Repellents for adult Tribolium confusum mandelates. *J. Ga. Entomol. Soc.* 12:79-84. 1977.
- Mullen, M. A., and R. T. Arbogast. Influence of substrate on oviposition by two species of stored-product insects. *Environ. Entomol.* 6:641-642. 1977.
- Press, J. W., B. R. Flaherty, and R. T. Arbogast. Interactions among Nemeritis canescens (Hymenoptera: Ichneumonidae), Bracon hebetor (Hymenoptera: Braconidae), and Ephestia cautella (Lepidoptera: Pyralidae). *J. Kans. Entomol. Soc.* 50:259-262. 1977.
- Highland, H. A., P. Sheehan, and W. H. Schoenherr. U.S.-AID overseas food storage and handling seminars. *Cereal Foods World* 22:291-292, 297. 1977.
- LeCato, G. L. Confused flour beetle: Growth and development stimulated by eating eggs or adults of the Indian meal moth. *Ann. Entomol. Soc. Am.* 70:555-558. 1977.
- LeCato, G. L. Growth and development of the red flour beetle in flour supplemented with eggs or adults of the Indian meal moth. *Ann. Entomol. Soc. Am.* 70:66-68. 1977.

- LeCato, G. L., J. Collins, and R. T. Arbogast. Reduction of residual populations of stored-product insects in a warehouse by Xylecoris flavipes (Hemiptera: Anthocoridae). J. Kans. Entomol. Soc. 50:84-88. 1977.
- Lum, P. T. M. Effect of glucose on autogenous reproduction of Bracon hebetor Say. J. Ga. Entomol. Soc. 12:150-153. 1977.
- Davis, R., and E. J. Jay. The current status of controlled atmospheres as a method of insect control. Proceedings of the 2nd National Controlled Atmosphere Research Conference, April 5-7, 1977. Horticultural Report No. 28:207-211. 1977.
- Gillenwater, H. B., and L. L. McDonald. Toxicity, repellency, and attractancy of slow-release insecticide dispensers. J. Ga. Entomol. Soc. 12:261-267. 1977.
- Highland, H. A. Chemical treatments and construction features used for insect resistance. Packag. Dev. Systems, pp. 36-38. 1977.
- Highland, H. A. Insect-resistant shipping bags: Protection for processed cereals. Mod. Packag. 50:37-38. 1977.
- Highland, H. A., L. D. Cline, and R. A. Simonaitis. Insect-resistant food pouches made from laminates treated with synergized pyrethrins. J. Econ. Entomol. 70:483-485. 1977.
- Smithwick, E. B., and U. E. Brady. Site and development of sex pheromone in developing female Indian meal moths, Plodia interpunctella. J. Ga. Entomol. Soc. 12:1-13. 1977.
- Su, H. C. F. Insecticidal properties of black pepper to rice weevils and cowpea weevils. J. Econ. Entomol. 70:18-21, 1977.
- Vardell, H. H., and E. G. Jay. Progeny production by single pairs of six mutant Tribolium and by ratios of wild-type to mutants. J. Ga. Entomol. Soc. 12:251-254. 1977.
- Zehner, J. M. and R. A. Simonaitis. Determination of pirimiphos-methyl formulations by high performance liquid chromatography. J. Assoc. Off. Anal. Chem. 60:14-15. 1977.
- Zettler, J. L. Fecundity of malathion-resistant Plodia interpunctella and Ephestia cautella. J. Ga. Entomol. Soc. 12:333-336. 1977.
- Zettler, J. L. Susceptibility of diapausing and nondiapausing larvae of Cadra cautella to malathion. J. Ga. Entomol. Soc. 12:56-58. 1977.
- Zettler, J. L., and R. Jones. Toxicity of seven insecticides to malathion-resistant red flour beetles. J. Econ. Entomol. 70:536-538. 1977.



Manhattan, Kansas

- Boles, H. P. and Y. Pomeranz. Effect of malting on development of rice weevils in barley. *J. Econ. Entomol.* 70:486-488. 1977.
- Bulla, L. A., Jr. Physiology of sporeforming bacteria associated with insects: Enzymatic analysis of the aerobic and anaerobic metabolism of Bacillus popilliae, Bacillus lentimorbus, and Bacillus larvae. In A. N. Barker, G. W. Gould, and J. Wolf (ed.), *Spore Research*. Academic Press, London and New York, pp. 407-419. 1978.
- Bulla, L. A., Jr., and T. C. Cheng (eds). *Comparative Pathobiology*. Vol. 2. *Biology of the Microsporidia*. Plenum Press, New York and London. 510 pp. 1977.
- Bulla, L. A., Jr., and T. C. Cheng. (eds). *Comparative Pathobiology*. Vol. 3. *Invertebrate Immune Responses*. Plenum Press, New York and London. 192 pp. 1977.
- Bulla, L. A., Jr., K. J. Kramer, and R. D. Speirs. Insects and micro-organisms in stored grain and their control. In *Advances in Cereal Science and Technology*, Vol. 2. (Y. Pomeranz, ed). American Association of Cereal Chemists, Inc., St. Paul, Minnesota, pp. 91-133. 1978.
- Bulla, L. A., Jr., K. J. Kramer, and L. I. Davidson, Characterization of the entomocidal parasporal crystal of Bacillus thuringiensis. *J. Bacteriol.* 130:375-383. 1977.
- Bulla, L. A., Jr., and F. A. Niernberger. Economic implications of losses occurring in the storage of grains. In *Proc. National Food Loss Conference*. (M. V. Zaehring and J. O. Early, eds), College of Agriculture, University of Idaho, pp. 119-123. 1977.
- Hyari, S., A. M. Kadoum, and D. W. LaHue. Laboratory evaluations of emulsifiable and encapsulated formulations of malathion and fenitrothion on soft red winter wheat against attack by adults of four species of stored-product insects. *J. Econ. Entomol.* 70:480-482. 1977.
- Kadoum, A. M., D. W. LaHue, and L. Alnaji. Efficacy and fate of pirimiphos-methyl residue applied at two dosage rates to wheat for milling. *J. Econ. Entomol.* 71:50-52. 1978.
- Kramer, K. J., and C. N. Childs. Interaction of juvenile hormone with carrier proteins and hydrolases from insect hemolymph. *Insect Biochem.* 7:397-403. 1977.
- Kramer, K. J., and H. E. McGregor. Activity of pyridyl and phenyl ether analogues of juvenile hormone against coleoptera and lepidoptera in stored grain. *J. Econ. Entomol.* 71:132-134. 1978.
- Kramer, K. J., R. D. Speirs, and C. N. Childs. Immunochemical evidence for a gastrin-like peptide in insect neuroendocrine system. *Gen. Comp. Endocrinol.* 32:293-295. 1977.

Kramer, K. J., H. S. Tager, C. N. Childs, and R. D. Speirs. Insulin-like hypoglycemic and immunological activities in honeybee royal jelly. *J. Insect Physiol.* 23:293-295. 1977.

LaHue, D. W. Chlorpyrifos-methyl: Doses that protect hard winter wheat against attack by stored-grain insects. *J. Econ. Entomol.* 70:734-736. 1977.

LaHue, D. W. Grain protectants for seed corn: Field test. *J. Econ. Entomol.* 70:720-722. 1977.

LaHue, D. W., and Bulla, L. A., Jr. Guidelines for evaluating the efficacy of chemical insecticides as protectants of stored grain against insect pests. *Bull. Entomol. Soc. Amer.* 23:117-118. 1977.

Law, J. H., P. E. Dunn, and K. J. Kramer. Insect proteases and peptidases. In *Advances in Enzymology*, Vol. 45 (A. Meister ed), John Wiley and Sons, New York, pp. 389-425. 1977.

McGregor, H. E. Note on residues in flour resulting from malathion applications in an operating mill. *Cereal Chem.* 54:1286-1287. 1977.

Quinlan, J. K. Surface and wall sprays of malathion for controlling insect populations in stored shelled corn. *J. Econ. Entomol.* 70:35-36. 1977.

Schesser, J. H., and L. A. Bulla, Jr. Toxicity of Bacillus thuringiensis spores to the tobacco hornworm, Manduca sexta. *Appl. Environ. Microbiol.* 35(1):121-123. 1978.

Schesser, J. H. Fumigation of cereal grains and processed products in transport vehicles with phosphine from Detia Ex-B. *J. Econ. Entomol.* 70:199-201. 1977.

Schesser, J. H., K. J. Kramer, and L. A. Bulla, Jr. Bioassay for homogeneous parasporal crystal of Bacillus thuringiensis using the tobacco hornworm, Manduca sexta. *Appl. Environ. Microbiol.* 33:878-880. 1977.

Sharpe, E. S., and L. A. Bulla, Jr. Germination and outgrowth of Bacillus popilliae spores in microscope slide culture. *J. Invertebr. Pathol.* 30:242-248. 1976.

Storey, C. L., Y. Pomeranz, F. S. Lai, and N. N. Standridge. Effects of storage atmosphere and relative humidity on barley and malt characteristics. *Brewers Digest* 52:40-43. 1977.

Tweeten, K. A., L. A. Bulla, Jr., and R. A. Consigli. Isolation and purification of a granulosis virus from infected larvae of the Indian meal moth, Plodia interpunctella. *Appl. Environ. Microbiol.* 34:320-327. 1977.

Tweeten, K. A., L. A. Bulla, Jr., and R. A. Conigli. Supercoiled circular DNA of an insect granulosis virus. *Proc. Nat. Acad. Sci. USA*, 74:3574-3578. 1977.

Beaumont, Texas

Cogburn, R. R. Resistance to the Angoumois grain moth in some varieties of rough rice from the USDA World Collection. J. Econ. Entomol. 70: 753-754. 1977.

Cogburn, R. R. Susceptibility of varieties of stored rough rice to losses caused by storage insects. J. Stored Prod. Res. 13:29-34. 1977.

Russell, M. P., and R. R. Cogburn. World Collection rice varieties: Resistance to seed penetration by Sitotroga cerealella. J. Stored Prod. Res. 13:103-107. 1977.

Richmond, Virginia

Fletcher, L. W. A procedure for collecting large numbers of eggs of Lasioderma serricorne (F.) J. Stored Prod. Res. 13:87-88. 1977.

Madison, Wisconsin

Burkholder, W. E. Manipulation of insect pests of stored products. In H. H. Shorey and J. McKelvey (ed.) Chemical control of insect behavior: Theory and application. Interscience Publ., New York. Chap. 20. 1977.

Shapas, T. J., W. E. Burkholder, and G. M. Boush. Population suppression of Trogoderma glabrum by using pheromone luring for protozoan pathogen dissemination. J. Econ. Entomol. 70(4):469-474. 1977.

Barak, A. V., and W. E. Burkholder. Behavior and pheromone studies with Attagenus elongatulus Casey (Coleoptera: Dermestidae) J. Chem. Ecol. 3(2):219-237. 1977.

Barak, A. V., M. Shinkle, and W. E. Burkholder. Using attractant traps to help detect and control cockroaches. Pest Control, October, 1977.

Fukui, H., F. Matsumura, A. V. Barak, and W. E. Burkholder. Isolation and identification of a major sex attractant component of Attagenus elongatulus Casey (Coleoptera: Dermestidae). J. Chem. Ecol. 3(5): 541-550. 1977.

Greenblatt, R. E., W. E. Burkholder, J. H. Cross, R. F. Cassidy, Jr., R. M. Silverstein, A. R. Levison, and H. Z. Levison. Chemical basis for interspecific responses to pheromones of Trogoderma species (Coleoptera: Dermestidae). J. Chem. Ecol. 3(3):337-347. 1977.

Cross, J.H., R. D. Byler, R. M. Silverstein, R. E. Greenblatt, J. E. Gorman, and W. E. Burkholder. Sex pheromone components and calling behavior of the female dermestid beetle, Trogoderma variabile Ballion (Coleoptera: Dermestidae). J. Chem. Ecol. 3(2):115-125. 1977.



Barak, A. V., and W. E. Burkholder. Studies on the biology of Attagenus elongatulus Casey (Coleoptera: Dermestidae) and the effects of larval crowding on pupation and life cycle. J. Stored Prod. Res. 13:169-175. 1977.

Barak, A. V., and W. E. Burkholder. A black body mutation of Attagenus elongatulus Casey (Coleoptera: Dermestidae). J. Stored Prod. Res. 13: 177-181. 1977.

ANNUAL REPORT  
FY 1977

National Research Program 20650

TECHNOLOGIES AND PRODUCTS TO INCREASE EXPORTS OF AGRICULTURAL PRODUCTS

This ARS National Research Program (NRP) is one of 2 programs designed to provide research support to the USDA Mission on agricultural exports which has the operating goal of developing commercial agricultural markets through promotion, representation and research. This NRP is concerned with development of new food and industrial products and processes with improved qualities, such as nutritional, functional, stable, economical, safe, and palatable. The research efforts include basic, developmental and applied technologies. They consider the needs of the foreign markets as well as increased market potential for our abundant commodities. Research under this NRP produces technical capability and support for other government agencies charged with distribution of food overseas. Action agencies such as AID need the technologies and products developed by SEA to help put their programs into operation.

NPS Contact: M. J. Pallansch

PACS Contact: C. Golumbic

Technological Objective 1.

Develop new and improved products and processes suitable for the export market.

Research Locations:

Albany, California  
Pasadena, California  
Peoria, Illinois  
New Orleans, Louisiana

Selected Examples of Recent Progress:

New process using less energy devised for producing quick-cooking rice - Albany, CA. A new process has been devised and successfully tested on a semi-commercial scale for production of quick-cooking rice. The process uses less energy, and unlike previous quick-cooking rice processes, performs on all varieties of rice, including wild rice.

Bread made from 100% rice flour gains consumer acceptance - Albany, CA. Bread made from 100% rice flour has been extremely successful for consumers unable to eat wheat breads. After newspaper coverage across the country, testimonials, etc., have been received as to the success and grateful thanks of consumers.

Technique developed for preserving light appealing color in sun-dried peaches - Albany, CA. It has always been difficult to produce sun-dried peaches with light, appealing color. This is because it is difficult to get sufficient sulfur dioxide, a chemical agent used to preserve color,

into the peach before drying. Peaches dry relatively slowly in sun drying yards, frequently requiring 10 days or more of drying time. During this period sulfur dioxide is continually volatilizing from the peaches. If the sulfur dioxide content becomes too low, the peaches rapidly darken. During the past several years a sulfuring method was developed under this project whereby the cut peaches are sprayed with a potassium bisulfite solution either before or after the conventional gaseous treatment in a sulfur house. This simple technique results in improved uptake and penetration of sulfur dioxide. The technique was demonstrated to the industry during the past two years, and it has now been commercially adopted by essentially all of the producers of sun-dried peaches. The product made using this technique maintains higher quality throughout storage, which should improve the position of dried peaches in many export markets.

Centrifugal fluidized bed (CFB) drier adapted to continuous process - Albany, CA. Conditions established for making quick-cooking rice products on a small scale batch centrifugal fluidized bed (CFB) drier were adapted to a continuous CFB unit. Minor equipment changes provided successful production capacity of 20-60 lbs/hr of dried instant type rice in continuous test runs up to 5 hours. Cooking quality and storage stability were comparable to commercial products. Several U.S. food companies and two foreign firms have expressed interest in commercial developments. Taste panels showed no preference between commercial rice and CFB-dried instant short, medium and long grain rice.

Undermilled brown rice process has potential - Albany, CA. Brown rice milled to remove 3 and 6% by wt. bran and polish was compared with white rice (10% removal). The undermilled samples showed significant improvement in retention of protein, fat, fiber, B-vitamins and minerals, and higher yields of total and head rice, with obvious economic advantages. Taste panel results showed no significant preference. All samples were rated highly acceptable.

High temperature storage tests of rice bread mix and rice flour have been completed - Albany, CA. The most noticeable changes, which appeared at six months, were development of off-odor, off-color, and off-flavor in the mix, flour, and bread. Part of the deterioration in the mix may be attributed to changes in the flour and part to the active dry yeast. Stored rice flour showed deterioration similar to those observed in the mix, indicating other ingredients, especially the hydroxypropyl methylcellulose (necessary in this product) do not deteriorate in stored mixes.

Properties needed to obtain moist, soft, smooth textured rice breads identified - Albany, CA. Physico-chemical characteristics and eating quality of several rice flours were compared with baking properties of the same flours. A combination of properties must be present for moist, soft, smooth-textured breads. These included low amylose content, low gelatinization temperature of the starch, low amylograph viscosity of the starch paste on cooling, and softness of cooked rice. Otherwise, rice breads had sandy, harsh texture. Texture differences obtained for 100% rice flour breads carried over to wheat flour breads when different rice flours were included as 30% replacement for the wheat flour.



Determined methyl oleate emulsions did not provide microbial protection for grapes - Albany, CA. Grapes were treated in vivo and in vitro with various levels of methyl oleate suspensions. Results in both cases indicated no significant antimicrobial protection, at least for yeast and mold, due to the use of the methyl oleate.

Degradation of potassium sorbate due to chemical and other than microbial action in high moisture prune test - Albany, CA. This project was undertaken to determine the stability to natural oxidation and microbial degradation of the antimicrobial compound potassium sorbate on high moisture prunes. Samples of prunes at about 35% moisture were dipped in 2% potassium sorbate solution, packaged, and stored at three different temperatures. Some samples were inoculated with known organisms; Aspergillus glaucus, Saccharomyces rouxii, and Saccharomyces mellis, prior to packaging. Results showed that the degradation of sorbate was due to chemical, rather than microbial action.

Specifications suggested for rice product similar to corn-soy-milk (CSM) - Albany, CA. Specifications have been suggested for a product similar to corn-soy-milk (CSM), in which the corn ingredient is replaced by cooked and ground rice. Provision was made for NFDM levels of 5, 10, 15 and 20%, allowing this ingredient to be varied according to availability. A commercially developed food, whole rice-extruded soy mix, was appraised and approved for government purchase, in response to a request from Washington.

Hot air treatments effective in reducing rice stickiness - Albany, CA. Evaluation of hot-air treated rices for stickiness by the WRRC Instron method, and by taste panels, showed excellent correlation and confirmed the effectiveness of hot-air treatments in reducing rice stickiness. Amount of cooking water, holding time after cooking and degree of milling had profound effects on stickiness and should be standardized in the Instron stickiness method.

Heat-treated wheat flours and partially swollen starch improved cake performance - Albany, CA. Laboratory and pilot plant preparations of heat-treated wheat flours and partially-swollen starch both improved cake baking performance and eating quality. Water retention capacity tests indicated changes similar to those observed with chlorine-treatment of flours.

Dough and baking properties of Bolivian flours assessed for composite flour studies - Albany, CA. Dough and baking properties of Bolivian flours have been assessed for composite flour studies incorporating soy, quinoa and/or rice with the wheat flours. Quinoa and rice had less adverse effects on dough and bread properties than soy. Blends of various compositions responded equally to bromate oxidation. Analyses of quinoa flour indicated considerably lower protein in flour than in whole seed (8% vs 12%), very small angular starch granules (1 micron), and starch gelatinization temperature in same range as wheat flour.

New method developed for synthesis of O-methylnucleotides - Albany, Ca. and Warsaw, Poland. A new method was developed for synthesis of O-methylnucleotides which are useful in studies of capped mRNA systems and

as anti-metabolites or model compounds. A nuclease was isolated from DNA-treated B. subtilis cells which may have a role in recombination of DNA strands during transformation. An E. coli strain was found to be extremely sensitive to 6-N-hydroxy 2-aminopurine in mutation induction. Both lethal and mutagenic lesions are removed simultaneously in this organism by cellular DNA. High molecular weight DNA, in contrast to sonicated DNA fragments, was not capable of eliciting an immunochemical response in rabbits after irradiation of the DNA with 8-methoxypsoralen.

Guayule yield increased with chemical treatments - Pasadena, CA. SEA scientists have chemically treated guayule, a desert shrub native to Texas and Mexico, causing the plant to produce over 3 times the rubber it normally yields. Such increase might lead to a commercially feasible, domestic natural rubber source to replace the 719,000 tons imported yearly at a cost of over \$500 million.

Organic solvent based formulations show promise on preharvest treatment of oranges for endocarp color improvement - Pasadena, CA. Studies were continued on the introduction of new formulations and combinations of bioregulators which would be more effective in less responsive periods and geographical areas and increase the naturalness of induced carotenoids. Emphasis was placed on preharvest treatment of oranges for endocarp color improvement. Organic solvent based formulations were tried in field tests, because these proved most successful in the laboratory. The diesel fuel based formulation appeared to be promising. Even when used on difficult to induce fruit, good color response in both the peel and endocarp was observed. Significant increases in actual carotenoid content of endocarp was measured. Preliminary studies with combinations of bioregulators appear to be promising.

Root application method for color inducing bioregulators - Pasadena, CA. The feasibility of inducing color in the endocarp by trans-location of the bioregulator through the roots was investigated. When they were applied to the root system of a potted lemon shrub, the bioregulators were quickly absorbed by the roots and translocated to the leaves and buds thus indicating a possible alternate method of application.

Control of regreening of Valencia oranges by bioregulators - Pasadena, CA. Of the twelve bioregulators examined in experiments on trees in Riverside, California, seven interfered with the regreening process confirming the results obtained last year. In four cases the inhibition appeared to be accompanied by enhancement or orange coloration of the rind. Also, it was observed that the duration of the action of these bioregulators is about one month. Treatments during the summer months appear necessary.

Preharvest application of bioregulators might induce fungal resistance in lemons - Pasadena, CA. The work on bioregulators was extended to include limited efforts on the chemical bioinduction of "antifungal" activity in citrus fruits. Initial results suggest that it might be possible to induce fungal resistance in lemons through the preharvest application of



bioregulators. Tests show that the bioregulators in themselves do not possess antifungal activity. Also, no antifungal activity was seen in postharvest treated lemons. However, resistance to Penicillium decay was observed in fruits from trees which had been sprayed with a solution of bioregulator. The leaves appear to be involved in the formation of the "antifungal" activity.

Information developed to select solvent compositions and extraction temperatures that result in good soy flour flavor stability - Peoria, IL. Ten samples of soy flour extracted with aqueous alcohols at different temperatures were placed into 25°C storage for 6, 9, and 12 months to determine if a flavor reversion problem exists. A few samples showed deterioration after 6 months but 6 of 10 samples showed no reversion of flavor or odor after 12 months of storage. This information will make it possible to select solvent compositions and extraction temperatures that result in good flavor stability.

Simple processes may be feasible to eliminate two carbohydrates that cause flatulence in soybeans - Peoria, IL. Reserve soybean carbohydrates consisting primarily of low-molecular weight oligosaccharides particularly sucrose, stachyose, and raffinose decreased rapidly during germination of soybean embryos and cotyledons. Experiments have begun to study mechanisms of this phenomenon and to optimize the parameters that affect the reduction of oligosaccharides during germination. Preliminary results show that both presteeping and germination are effective and that simple processes may be feasible to eliminate stachyose and raffinose, two carbohydrates that cause flatulence in soybeans.

New source of peanut protein - New Orleans, LA. Plant proteins to be used in food products must have a bland flavor, plus other desirable properties. Defatted flour prepared from white skin peanuts was found to have good protein values, 70-90% protein solubility, as much as 8-fold higher calcium content when the skins were not removed before processing, bland flavor, and low flatulence-causing sugars. These peanuts may be potentially good sources of oilseed protein for food applications.

Improved TLC method for separating amino acids and lipids - New Orleans, LA. Previous methods for separating polar amino acids and non-polar lipid peroxides in stale or rancid oilseed protein products involved thin layer chromatography (TLC) in two or more phases and different solvent systems. A method was developed that separates the unreacted amino acids, linoleic acid, linoleic acid hydroperoxide, and the amino-lipid peroxide reaction product in one direction only with a single solvent system of petroleum ether-diethyl ether-glacial acetic acid. This simple system can be used to study the effects and binding sites of peroxidized lipids on proteins in stale or rancid peanut (or other oilseed) products.

Edible protein flour from white skin peanuts - New Orleans, LA. Preliminary chemical tests on defatted peanut flour from red and white skin peanuts showed good potential for white skin peanuts as a new source of food grade protein. Five varieties of white skin peanuts were analyzed and



compared for compositional and nutritional parameters. Two of these had total protein profiles equal to that in red skin peanuts, good protein solubility, and little or no flatulence-causing sugars. In addition, they did not have to be blanched (a saving in processing costs), they have higher calcium levels than other oilseed proteins, and they have bland flavor. These peanuts may be useful as a source of plant protein for food applications, especially in milk-type beverages.

Partially defatted peanut flours - New Orleans, LA. Flours were prepared from peanuts which have had 55% of the original oil removed by mechanical means. These flours provide a basic source of high-protein food material for incorporation into food products to improve their nutritive and functional value. Peanut flours with a range of flavors from raw to bland to fully roasted can be made available based on specific food product requirements. At least two companies are now marketing the flours and others have expressed considerable interest in the development. It is known that one of the companies has produced over two million pounds in 1977 having an estimated value of over \$1.3 million. Production of these flours involves the use of over 3.6 million pounds of farmers stock peanuts.

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This Annual Report was prepared by Harold Ricker, Agricultural Marketing Research Institute, Beltsville, Maryland.

PUBLICATIONS

Albany, California

Bean, M. M., J. M. Hanamoto, K. D. Nishita, D. Mechan and D. A. Fellers. 1977. Soy-fortified wheat flour blends. IV. Storage stability with several surfactant additives. Cereal Chem. 54:1159.

Fellers, D. A. and M. M. Bean. 1977. Storage stability of wheat-based foods: A Review. J. Food Sci. 42:1143-1147.

Hanamoto, M. M. 1977. Preparation of icings. U.S. Patent No. 3,955,008.

Hanamoto, M. M. and M. M. Bean. 1977. Potential new surfactants for the baking industry. Baker's Digest 50:31-34, 39.

Nishita, K. D. 1977. A yeast-leavened, rice flour bread. J. Amer. Dietet. Assoc. 70:397.

Nishita, K. D. and M. M. Bean. 1977. Physico-chemical properties of rice in relation to rice flour bread. Presented at the 62nd Annual Meeting, Amer. Assn. Cereal Chemists, San Francisco, California.

Roberts, R. L. 1977. Effect of microwave treatment of presoaked paddy, brown and white rice. J. Food Sci. 42:804-806.

Roberts, R. L. and T. Wasserman. 1977. Effect of milling conditions on yields, milling time and energy requirements in a pilot scale Engelberg Rice Mill. J. Food Sci. 42:802-804.

Stafford, A. E. and D. G. Guadagni. 1977. Storage stability of raisins dried by different procedures. J. Food Sci. 2(42):547-548.

Stafford, A. E. 1976. Rapid analysis of potassium sorbate in dried prunes by ultraviolet or colorimetric procedure. Ag. and Food Chem. 24(4):894-895.

Pasadena, California

Hayman, E. P., H. Yokoyama and S. M. Poling. Carotenoid induction in orange endocarp. J. Agric. Food Chem. 25:1251, 1977.

Maier, V. P., and H. Yokoyama. The concept of bioregulation of plant composition and its application to quality improvement of citrus fruit. In Citrus Processing Science and Technology. Vol. I (Nagy, S., P. Shaw, and M. Veldhuis, Eds.) Avi Publishing Co., Westport, Connecticut (1977).

Poling, S. M., W. J. Hsu, F. D. Koehn and H. Yokoyama. Chemical inducers of  $\beta$ -carotene biosynthesis. Phytochem. 16:551, 1977.

Yokoyama, H., E. P. Hayman, W. J. Hsu and S. M. Poling. Chemical bioinduction of guayule rubber. Proceedings International Guayule Conference, Saltillo, Mexico, 1977.

Yokoyama, H., E. P. Hayman, W. J. Hsu and S. M. Poling. Chemical bioinduction of rubber in guayule. Science 197:1076, 1977.

Yokoyama, H., W. J. Hsu, S. M. Poling, E. P. Hayman and C. DeBenedict. Bioregulators and citrus fruit color. Meeting of International Society Citriculture, Orlando, Florida, May, 1977.

#### Peoria, Illinois

Baker, E. C., G. C. Mustakas, and V. E. Sohns. Crambe Processing: Glucosinolate Removal by Water Washing on a Continuous Filter. J. Am. Oil Chem. Soc. 54 (1977) 387-391.

Baker, E. C., G. C. Mustakas, M. R. Gumbman and D. H. Gould. Biological Evaluation of Crambe Meals Detoxified by Water Extraction as a Continuous Filter. J. Am. Oil Chem. Soc. 54 (1977):392-296.

#### New Orleans, Louisiana

Conkerton, E. J., L. L. Bourgeois, and R. L. Ory. Evaporator for Moisture-Sensitive Materials, Lab. Practice 26, 483, (1977).

Ory, R. L. and A. J. St. Angelo, editors; Enzymes in Food and Beverage Processing. Published by: American Chemical Society (1977) 336 pages.

Ory, R. L. and A. A. Sekul. Spectrophotometric Assay Curves as Anomalous Indicators of Proteolysis of Oilseed Proteins. J. Food Biochem. 1, 67-74, 1977.

Pominski, J., H. M. Pearce, Jr., and J. J. Spadaro. Direct Extraction Process for the Production of a White Defatted, Food-Grade Peanut Flour: II. Heat and Moisture Treatment for Producing Bland Flours, 9th Annual Meeting of the American Peanut Research and Education Association, July 12-15, 1977, Asheville, N.C.

Pominski, J. and J. J. Spadaro. Milk-like Products from Peanuts. U. S. Patent No. 4,025,658, May 4, 1977.

St. Angelo, A. J. and J. C. Kuck. Effects of Cyanide on Peanut Lipooxygenase. Lipids 12:682-683 (1977).

St. Angelo, A. J., J. C. Kuck, and R. L. Ory. Enzymes and Oxidative Stability of Peanut Products. Chapter 18. IN: Enzymes in Food and Beverage Processing, R. L. Ory and A. J. St. Angelo, editors, ACS Symposium Series 47, American Chemical Series, Washington, D. C., 1977.



ANNUAL REPORT  
FY 1977

National Research Program 20660

SYSTEMS FOR OVERSEAS MARKETING

National Research Program 20660 involves basic and applied research to help increase exports of agricultural products to foreign markets by (1) maintaining and/or improving the quality of the products delivered and (2) reducing the costs of handling, packaging, and transportation of U.S. products to such markets. The range of commodities involved in this program is limited to those with export potential in the broad areas of horticultural crops, livestock and animal products, and field crops. The work encompasses physiological, biochemical, pathological, microbiological, and entomological problems encountered during the preparation, storage, transport, and distribution of agricultural commodities in the export marketing channels. The functions to which the physical elements relate are assembling, preparing for export, processing, packaging, precooling, loading, transporting, unloading, storing, warehousing, and wholesale and retail distribution. The main thrust of the program is to develop an export system in which there is total control of the product quality and physical elements from the U.S. farm to the foreign consumer.

NPS Contact: (Dale Anderson, Interim)

PACS Contact: C. Golumbic

Technological Objective 1.

Develop, evaluate, and demonstrate new or improved technologies to maintain product quality and reduce losses in the export marketing channels.

Research Locations:

Fresno, California  
Riverside, California 1/  
Orlando, Florida  
Beltsville, Maryland  
Weslaco, Texas  
Wenatchee, Washington  
Rotterdam, The Netherlands

Selected Examples of Recent Progress:

Export Losses Reduced in Air Shipments of Strawberries: Fresno, CA.

The use of modified atmospheres and improved refrigeration practices for export shipments of strawberries have cut losses to about 1/3 of those in fruit shipped by older methods. About 3.3 million pounds of strawberries are shipped by air to overseas markets with a delivered price of about \$5 million. The improved arrival condition of this crop has led to further increases in the volume of fruit shipped to European and Far Eastern markets.

1/ This work has been transferred to Fresno, CA.

Simulated Export Tests with new USDA Experimental Refrigerated Van-Container Work Very Well: Fresno, CA. Five simulated export shipping tests were conducted with lettuce, celery, melons and citrus to determine the overall performance of the experimental USDA refrigerated van-container prior to conducting actual export shipments. In each of the five tests commodity temperatures were rapidly reduced after loading and were maintained within a few degrees of the desired level during transit. The most dramatic results occurred with a tight-stacked load of citrus that was packaged in corrugated cartons. The fruit was loaded with an average pulp temperature of 68°F with a range of 66° to 71°. The thermostat was set at 45°F and within 48 hours, the average pulp temperature was reduced to 46°F, with a spread of only 44° to 50°. The planned overseas shipping test with the new USDA van-container was postponed due to scheduling problems and is now scheduled in 1978.

Low Oxygen Atmospheres Plus CO<sub>2</sub> Reduce Lettuce Decay. Fresno, CA. Laboratory tests were continued to determine the effects of modified atmospheres on decay of lettuce held under simulated export conditions (3 weeks at 37°F or 41°). Oxygen levels in the range of 5 to 14% reduced decay, and carbon dioxide (CO<sub>2</sub>) levels in the range of 3 to 6% also reduced decay. The reduction was greatest when both low oxygen and slightly elevated CO<sub>2</sub> levels were used. CO<sub>2</sub> injury (brown stain) was not a problem in desert-grown lettuce, but some CO<sub>2</sub> injury occurred in Salinas-grown lettuce. Additional combinations of CO<sub>2</sub> and oxygen are being tested.

Research Gets Thiabendazole (TBZ) Residue Tolerance Raised Improving Effectiveness of This Fungicide on Citrus. Riverside, CA. Thiabendazole (TBZ) residues and TBZ stability in treated whole oranges, wet pulp, juice, molasses, oil, and dry citrus pulp for cattle feed were measured and the results used to help change the U.S. tolerance of this postharvest citrus fungicide from 2 to 10 ppm. Increasing the residues of TBZ allowed on citrus fruit greatly increased the effectiveness of this fungicide and reduced losses during storage and shipment due to fruit decay and spoilage.

Modified Refrigerated Rail Cars More Effective in Cooling Citrus. Riverside, CA, Beltsville, MD. It was found that warm citrus shipped in mechanically refrigerated rail cars with conventional over-the-load air distribution (OLAD) was not cooled adequately in all sections of the load when cartons were loaded in the conventional chimney air-stack pattern. Two under-the-floor air delivery (UFAD) systems provided more uniform fruit cooling throughout the load, especially when cartons were solid-stacked. Proper cooling of citrus fruit in mechanically refrigerated rail cars will encourage the use of energy-conserving rail transportation, and reduce the need for expensive, energy-consuming, refrigerated "pre-cooling" rooms in citrus packinghouses.

New Procedure Developed For Measuring Residues of Imazalil. Riverside, CA. An improved, more convenient method of measuring residues of the candidate fungicide, imazalil, was developed using high pressure liquid chromatographic and electron capture gas chromatographic methods. It is more practical than existing methods and is in use by researchers to determine residue levels needed on citrus fruit for fungus decay and sporulation control.



Freeze Damage Increases Inside Grapefruit Long After Harvest. Orlando, FLA. Immediately after severe winter freezes, an embargo is imposed on harvesting and shipping citrus fruits to protect the consumer against internal freeze damage which is manifested as internal drying and less juice. An insipid flavor may also be present. The embargo is lifted after much of the damaged fruit has dropped from the tree; thereafter, the fruit is graded by inspectors cutting samples and rating them according to U.S. No. 1, U.S. No. 2, etc. The research results with grapefruit exported to Japan showed that the internal drying continued to develop after inspection, often with fruit becoming a lower grade from shipping point to arrival at destination. This deleterious change was not previously known to occur so long after harvest. Over \$20 million Florida grapefruit are exported annually to Japan.

Grapefruit Arrivals to Japan Better in Deeper Box. Orlando, FLA. Results of test shipments showed grapefruit arrived in better condition when packed in boxes designed 1.27 cm deeper than the standard size boxes. Most of the grapefruit currently being shipped to Japan is now treated with SOPP and is packed in the new, deeper container.

Bulk Bin Tests for Shipping Grapefruit and Lemons to Europe Initiated. Orlando, FLA, Weslaco, TX. Texas grapefruit were evaluated under commercial conditions for exporting fruit to England. Results showed (1) that the wood-type bins had less bulge than the fiberboard type bins; (2) there were no major differences in condition of those fruit in bulk bins compared with fruit in standard 4/5-bushel boxes; (3) fruit decay was slightly lower in the wirebound bins than the other type bins tested; and (4) there were insignificant differences in pulp temperatures of fruit in the different types of bins. Cost data for exporting fruit in bin containers were not developed.

Bulk Wirebound and Fibreboard Bins Meet APHIS Fumigation Requirements. Orlando, FLA. Fumigation tests conducted to determine if grapefruit can be effectively fumigated in bulk bins, in accordance with APHIS requirements. Results with Florida grapefruit packed in bulk wirebound and fiberboard bins, and tested under Animal and Plant Health Inspection Service, USDA (APHIS) fumigation procedures, indicated that the experimental bins are acceptable for the export of grapefruit requiring fumigation with ethylene dibromide.

Improved Systems for Monitoring of Temperature in Aircraft Transporting Animals Developed. Beltsville, MD. In connection with research on air transport of animals, SEA researchers developed a system whereby the flight engineer can monitor 20 different locations in the compartment containing the animals. This system replaced a single point temperature indicator on the aircraft which did not give a reliable ambient temperature indication for all animal locations, resulting in over-heating of animals in lower pens where ventilation is restricted. This new 20-point temperature indicator system eliminated that problem.



Improved Procedures Developed for Sea Transport for Livestock. Beltsville, MD. In September 1977 researchers accompanied a load of beef steers (60 head - 612 kg) on a ship from Portland, Oregon to Yokohama, Japan, to evaluate larger pens and other deviations from USDA regulations. As a result the regulations have been modified to allow larger pens (20 animals from the former maximum of 4 per pen) and roofs of plastic tarps or other material on open deck pens instead of the 2-inch tongue and groove planking called for formerly. Rubber mats glued to the steel deck will replace the 1 x 4 strips nailed to the deck to give the animals good footing during 20° to 30° rolls. Since sea travel to Japan takes about 14 days instead of the 20 hours by air, the animals require more care and this offsets the lower sea fares.

Penicillium digitatum Grows Well on Lactose. Weslaco, TX. All isolates of P. digitatum tested grew well on lactose as the carbon source. This is contrary to published reports. When P. italicum and P. digitatum were grown on mannitol or lactose, respectively, spore production decreased with a concomitant increase in aerial hyphae. This phenomenon usually occurred as mycelial sectors within individual cultures.

Opening of Japan to Fresh Cherries. Wenatchee, WA. SEA/FR scientists have contributed much in the way of basic data on fumigation and its effect on cherry quality to play an important role in getting Japan to open the door to their markets. This research is developing new and improved technologies in packing and shipping fresh cherries long distances by ocean as well as by air. Although Japan leads the list of U.S. overseas trading partners at this time and has more than half the population of this country, these new technologies may help provide the opportunities for growth of trade in the Pacific Basin--China, Eastern USSR, Korea, Hong King, Taiwan, the five members of the ASEAN, Malaysia, Singapore, the Philippines, Thailand, and Indonesia, Australia and New Zealand. Other fresh commodities such as pears and apples will benefit from the knowledge gained in shipping fresh cherries such long distances.

Rotterdam Responds to Approximately 300 Inquiries Per Year from Importers of U.S. Agricultural Products and Agricultural Attaches. Rotterdam, The Netherlands. An objective of this laboratory is to respond to requests and provide information to European receivers of U.S. agricultural products and U.S. agricultural attaches in Europe. An average of 25 requests per month have been documented. These requests included observations of U.S. shipments, identification of disorders, and proper procedures for shipping products such as optimum environmental conditions and preharvest treatments.

Technological Objective 2.

Reduce costs in distribution and marketing systems by increasing physical efficiency, reducing energy requirements, and improving work methods.

Research Locations:

Fresno, California  
Orlando, Florida  
Beltsville, Maryland  
Rotterdam, The Netherlands

Selected Examples of Recent Progress:

Parallel Air-channel Stowage Patterns Provided More Uniform, Cooler Shipment. Orlando, FLA. Three commercial shipments of mixed loads of fresh fruits and vegetables were monitored for product temperatures and arrival condition. These shipments were loaded in parallel air-channel stowage patterns. Product temperatures in the loads in parallel air-channel stowage patterns were more uniform and closer to the thermostat setting upon arrival compared to mixed shipment loads. Faster product cooling and maintenance of product temperatures near the desired temperature level will assist in maintaining the product quality. Recommendations will be published when data reviewed.

Modified Dry Freight Van-container Performs Well in Tests with Perishable Products. Beltsville, MD. Test shipments of grapefruit from Florida, onions from New York, and garlic from Baltimore were sent to Europe aboard U.S. container ships in the modified dry freight van container. All products arrived in satisfactory condition. The tests were conducted during the colder months of the year, using outside air to keep the products cool. A thermostatically controlled blower heater, and louvers metered incoming air. Test results indicated that the system could be further improved by insulating the container roof and refinement in the air ducts and control system. A test shipment of flower bulbs was sent in the test container from the Netherlands to the U.S. with the bulbs arriving in satisfactory condition. Sample bulbs from the experimental van and a controlled refrigerated van container were force-sprouted at Michigan State University and compared. There were no significant differences in flowers grown from bulbs transported in the mechanically refrigerated van or the ambient air-cooled van container. Use of this system of cooling the products makes it possible to use less expensive, more plentiful dry freight van containers in place of the more expensive and less plentiful refrigerated van containers at a very considerable savings in refrigeration costs.

Tests Indicate that Grapefruit in Bulk Bins Should Not be More than 30 Inches Deep. Rotterdam, The Netherlands. To study the potential of shipping U.S. citrus in bulk to Europe, four types of bulk bins were evaluated for transporting grapefruit. Results of this test indicated that fruit should not be filled to a depth of more than 30 inches in bins and that condition of fruit was not significantly improved over the fruit arriving in conventional boxes. Utilizing bulk bins as a method of handling fresh citrus will allow relatively rapid loading and discharging from the ship's hold.

### Technological Objective 3.

Provide periodic technological evaluations of competitive foreign agricultural products and foreign physical distribution and marketing systems.

### Research Locations:

Fresno, California  
Rotterdam, The Netherlands

### Selected Examples of Recent Progress:

Improved Refrigerated Van-Containers. Fresno, CA. Design criteria developed by SEA/FR researchers to improve transit environments in refrigerated van-containers for fresh fruits and vegetables shipped to overseas markets have been adopted on a large scale by a leading foreign flag ocean carrier. A fleet of over 400 units valued at more than \$12 million are now supplying weekly service from the U.S. to Europe. They are transporting over \$26 million worth of U.S. perishables annually with losses of less than 2%. These new units greatly enhance the ability of shippers to increase exports sales by delivering high quality products overseas with fewer losses.

European Buyers Continue to Prefer Smaller Size Packages of Various Fresh Fruits and Vegetables. Fresno, CA. European buyers continue to make requests to U.S. exporters for smaller size packages of various fresh fruits and vegetables to better meet their own market requirements. The European trade traditionally uses smaller size packages for such items as peppers, lettuce, celery, and grape. A 5 Kg. grape box and a one-layer (5-12 head) lettuce pack are preferred. Smaller heads of lettuce are preferred.

Selected Quality Problems with U.S. Agricultural Products Identified. Fresno, C. Problem areas reported for U.S. products were excessive decay, crushing, and SO<sub>2</sub> injury of table grapes, chilling injury of early-season grapefruit, sour rot of lemons, molding of in-shell walnuts, insect infestations of lettuce, and internal breakdown of nectarines and plums. Importers reported good arrivals of Santa Rosa and Casselman plums, moderate success with El Dorado and Laroda, and poor results with Queen Ann because of internal breakdown.



Studies Completed on Quality and Composition Attributes of Grapefruit, Lemons and Oranges Arriving from all Countries on the Rotterdam Market. Rotterdam, The Netherlands. A grapefruit report has been completed and is awaiting publication. The lemon report analyzing seasonal changes in quality, composition and ascorbic acid content of lemons from all sources arriving on the Rotterdam market is nearly completed. Data collection has been completed on the orange study and it is being analyzed.

Data Collected on the Type and Size of Shipping Containers Used for Marketing 35 Fruits and Vegetables which U.S. Producers Could Export to Europe. Rotterdam, The Netherlands. Information is available on the dimensions on containers used for most of the commodities that might be marketed by U.S. producers by contacting the laboratory. A report is being prepared describing the shipping containers used in the common terms for packaging and accessory packaging materials.

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This Annual Report was prepared by Harold Ricker, Agricultural Marketing Research Institute, Beltsville, Maryland.

PUBLICATIONS

Fresno, California

Harvey, J., M. and M. Uota. Table Grapes and Refrigeration: Modified Atmospheres, in Particular the Influence of SO<sub>2</sub>. Proc. Symposium on Table Grapes and Refrigeration (Paris). Intl. Inst. Refr. 10 pp. 1977.

Harvey, J. M. Reduction of Losses in Fresh Market Fruits and Vegetables. In Ann. Rev. Phytopath. 16:20 pp. 1978 (In press).

Houck, L. G. Problems of Resistance to Citrus Fungicides. Proc. 3rd Intl. Citrus Symp. 1:263-269. (1977).

Riverside, California

Norman, S. M. and D. C. Fouse. Extraction of Imazalil from Treated Citrus Fruit and Determination of Residues by High Performance Reverse Phase Liquid Chromatography. Jour. Assoc. Official Anal. Chemists (In press). 1977.

Orlando, Florida

Hale, P. W., W. R. Miller, D. L. von Windeguth, and J. King. Ethylene dibromide fumigation of grapefruit packed in tray-pack containers and in bulk bins. Proc. Fla. State Hort. Soc. 90: (in press). Reprinted in Citrus and Vegetable Magazine 41(4):10-13, 26 and 29, 1977.

Hatton, T. T., J. J. Smoot, and P. W. Hale. Internal freeze damage in Florida grapefruit held in Florida and similar fruit shipped and held in Japan during late spring 1977. Proc. Fla. State Hort. Soc. 90:(in press). 1977.

Miller, W. R. and W. W. Carter. Bulk pallet bins for shipping Texas grapefruit. 35th Annual Texas Citrus & Vegetable Growers and Shippers. Sept. 1977. pp. 115, 117, 118 and 120.

Smoot, J. J. and P. W. Hale. Evaluation of decay control treatments and shipping containers for export of grapefruit to Japan. Proc. Fla. State Hort. Soc. 90: (in press). 1977.

Beltsville, Maryland

Ashby, B. H. and T. F. Webb. To improve livestock transport and handling. Agr. Engin. 58(4):34-37. 1977.

Bailey, W. A. and B. B. Ashby. Improving transport conditions for livestock. West. Livestock Jour. 55(59):18-20. 1977.

Kindya, W. G. Modifications in ambient air-cooled van container for transporting agricultural products to overseas markets. U.S. Dept. Agr., ARS-NE-83. 1977.

Kindya, W. G. Tests show promising future for sea-air cooled container. Jour. Internatl. Cargo Handling Co-ordination Assoc. 4(9):53-57. 1977.

Nicholas, C. J. Analysis of selected shipments of U.S. and other soybeans received in Japan, 1972-76. Accepted for publication by U.S. Dept. Agr., ARS-NE Series. 1977.

Nicholas, C. J. and W. A. Bailey. Transport problems in marketing soybeans overseas. Proc. World Soybean Res. Conf., pp. 762-770. 1976.

Nicholas, C. J. Enhancing and maintaining soybean quality in the harvesting--marketing system: II Marketing researcher's view. Proc. Amer. Soc. of Agr. Engin. Accepted for publication. 1977.

Stevens, D. G., B. H. Ashby, W. A. Bailey, K. E. Hoke and W. H. Kindya. Environmental conditions on air shipment of livestock. Accepted for publication in Trans. of the ASAE.

#### Weslaco, Texas

Carter, W. W. and W. R. Miller. Bulk pallet bins for shipping Texas grapefruit. In 35th Annual Texas Citrus and Vegetable Growers and Shippers, p. 115, 117, 118 120. (1977).

#### Rotterdam, The Netherlands

Bongers, A. J. Slipsheet handling of citrus. Int. Fruit World 35(2): 211, 213-14, 217-18, 221-22, 225, 227-28. (1977).

Hillebrand, B. M., and W. R. Miller. Slipsheets for handling grapefruit in van containers from the United States to Europe. Fruchthandel No. 8 (24 Feb.) 333-335. (1977).

Hale, P. W., W. R. Miller, D. L. Von Windeguth and J. King. Ethylene dibromide fumigation of grapefruit packed in tray-pack containers and in bulk bins. Citrus and Veg. 41(4):10-13, 26, 29. (1977).

Hinds, R. H. and A. J. Bongers. Highway and railroad equipment for transporting perishables in Europe. U. S. Dept. Agric. Mrkt. Res. Rept. 1061. (1977).

McDonald, R. E. and T. B. O'Connell. Citrus fungicide residues and legislation in western European countries. Proc. Int. Soc. Citriculture 1:296-298. Invitational Paper (1977).



McDonald, R. E., L. A. Risse, and A. J. Bongers. Packing and packaging of table grapes. Int. Inst. Refrigeration, Commission C2. Acpt. for publication. Invitational Paper (1977).

Miller, W. R., L. A. Risse, B. M. Hillebrand, T. Moffitt and W. R. Black. Unitized versus hand loading of van containers for exporting Florida grapefruit. U.S. Dept. Agric. Mrkt. Res. Report 1068. (1977).

Miller, W. R., T. Moffitt, L. A. Risse, A. Bongers and F. S. Marousky. Importance of handling and shipping practices in exporting leatherleaf fern via van containers. Southern Florist and Nurseryman 90(1):33-37. (1977).

Stewart, J. K., A. J. Bongers, T. R. Hinsch, R. H. Hinds, B. M. Hillebrand and W. G. Chace. Guides to successful lettuce exporting. Western Grower and Shipper 48(1):13-15. (1977).

Wardowski, W. and R. E. McDonald. Citrus postharvest fungicide tolerances. Florida Packinghouse Newsletter No. 88. (1977).

ANNUAL REPORT  
FY 1977

National Research Program 20820

CHEMICAL RESIDUES AND ADDITIVES IN FOOD AND FEED

This is one of three National Research Programs aimed at improving human health and safety. The purpose of the research is to provide information on the occurrence of environmental contaminants in food and feed; to develop new and/or improved technologies for determining the presence of nitrosamines in cured meats as a result of adding nitrites during the curing process and find less hazardous preservatives.

NPS Contact: H. W. Hays

PACS Contact: C. Golumbic

Technological Objective 1:

Devise means to reduce or eliminate hazardous environmental contaminants in food and feed products.

Research Locations:

Peoria, Illinois  
Wyndmoor, Pennsylvania  
Albany, California

Selected Examples of Recent Progress:

Uptake of heavy metals in selected food crops grown on normal soil types - Peoria, ILL. Radioactive zinc-65 can translocate to various parts of the corn plant, i.e., leaves, stems, roots, husks, cobs, and kernels, but the largest amount appears in fat germ fraction of the kernel.

Uptake of heavy metals in selected food crops grown under different soil treatment conditions - Peoria, ILL. Fifteen different crops were grown under different soil treatments, which included brown loam, clay, and black topsoil plus three inches of solid sewage sludge. Zinc, lead, cadmium, and mercury content increased in brown loam, clay, and black topsoil when sewage sludge was added. Crop yields increased in 14 crops when sludge was added to clay, 12 in brown loam and only 6 in black topsoil.

Technological Objective 2:

Prevent hazardous chemical reaction products from forming during curing and cooking food products.

Research Locations:

Wyndmoor, Pennsylvania  
Albany, California

### Selected Examples of Recent Progress:

Determination of relationship between composition of pork bellies and volatile nitrosamines. The composition (fat, moisture and protein) of pork bellies was significantly different within the same side but no difference in the same sections from side-to-side of matched pairs. The concentration of N-nitrosopyrrolidine (NPYR) in fried bacon and drippings is directly correlated with residual nitrite.

Evaluation of  $\alpha$ -tocopherol ( $\alpha$ -toc) as an inhibitor of nitrosamine formation.  $\alpha$ -Tocopherol solubilized with polysorbate 20 significantly inhibits the nitrosation of pyrrolidine in a bacon model system.  $\alpha$ -Tocopherol and sodium ascorbate or  $\alpha$ -toc at 500 ppm inhibits N-nitrosopyrrolidine (NPYR) formation more effectively than ascorbate alone.

Effect of storage temperature on pork bellies of nitrosamine formation. More N-nitrosopyrrolidine is formed from frying refrigerated pork bellies than from frying bellies that were frozen and thawed. The least amount of NPYR is formed from fresh bellies.

Isolation, detection and confirmation of volatile and nonvolatile nitrosamines. A method was developed to determine volatile nitrosamines in gastric contents and in blood. A procedure was developed for determining N-nitrosodipropylamine (NDPA) in soybeans, a contaminant present in a dinitroaniline herbicide.

Relationship of proline and other amino acids to the concentration of nitrosamines in bacon. It was previously thought that nitrosoproline (NPRO) was the precursor of N-nitrosopyrrolidine (NPYR) via decarboxylation during frying but results of recent studies suggest that NPRO is not the primary precursor of NPYR. Analysis of fried bacon has shown the dimethylnitrosamine (NDMA) and NPYR are independent of free amino acid concentrations, including proline.

Methods of cooking bacon and presence of nitrosamines. Baking, broiling or frying bacon by either gas or electric heat results in the formation of NDMA or NPYR. Frying bacon at low to moderate heat for less than 10 minutes appears to result in less than 10 ppm nitrosamines.



Effect of eating high nitrate-containing vegetables on nitrosamine formation in human gastric juice - Wyndmoor, PA. Several human volunteers have consumed diets containing fish, spinach and vegetable juice. Preliminary results show confirmable concentrations of dimethyl and diethylnitrosamine in the gastric juice and urine.

Evaluation of chemicals as anticlostridial substitutes for nitrite - Wyndmoor, PA. Acidification of ham shows promise as an effective anti-clostridial method. Sorbic acid is only slightly effective as an anti-clostridial agent when used alone but in combination with  $\text{NO}_2$  is very effective. Many compounds recognized as anticlostridial show little or no activity in a comminuted meat system.

Reduction of water activity in bacon as a means of controlling clostridium botulinum growth - Wyndmoor, PA. Partial dehydration of non-nitrated bacon slices at  $70^\circ \text{C}$ . inhibited the growth of botulinum spores at a water activity ( $a_w$ ) of 0.91. This was further potentiated by the addition of small amounts of  $\text{NO}_2$ .

Synthesis of a compound producing bladder cancer - Albany, CA. N-(butyl-N-(3-carboxypropyl)nitrosamine (BCPN) which produces bladder cancer in experimental animals, was synthesized by a short and efficient method which now makes it possible to synthesize and study a series of homologous bladder-specific nitrosamino acid carcinogens.

PUBLICATIONS

Peoria, Illinois

- Garcia, W. J., R. H. Hodgson, C. W. Blessin, and G. E. Inglett.  
Preparation of corn products endogenously labeled with zinc-65 for  
use in bioavailability studies. J. Agr. Fd. Chem. 25:1290. 1977.

Wyndmoor, Pennsylvania

- Doerr, R. C., and W. Fiddler. Photolysis of volatile nitrosamines  
at the picogram level as an aid to confirmation. J. Chromatog. 140:  
284-287. 1977.
- Dymicky, M., C. N. Huhtanen, and A. E. Wasserman. Inhibition of  
Clostridium botulinum by 5-nitrothiazoles. Antimicrobial Agents  
and Chemotherapy 12:353-356. 1977.
- Fiddler, R. N. Collaborative study of modified AOAC method of analysis  
for nitrite in meat and meat products. J. Assoc. Offic. Anal. Chem. 60:  
594-599. 1977.
- Fiddler, W., J. W. Pensabene, R. C. Doerr, and C. J. Dooley. The presence  
of dimethyl- and diethylnitrosamines in deionized water. Fd. Cosmet.  
Toxicol. 15:441-443. 1977.
- Pensabene, J. W., W. Fiddler, J. Feinberg, and A. E. Wasserman.  
Evaluation of ascorbyl monoesters for the inhibition of nitroso-  
pyrrolidine formation in a model system. J. Fd. Sci. 41:199-200.  
1976.
- Wasserman, A. E., W. Kimoto, and J. G. Phillips. Consumer acceptance  
of nitrite-free bacon. J. Fd. Protection 40:683-685. 1977.
- Wasserman, A. E., J. W. Pensabene, and E. G. Piotrowski. Nitrosamine  
formation in home-cooked bacon. J. Fd. Sci. 43:276-277. 1978.

Albany, California

- Gaffield, W. L. K. Keefer, and P. P. Roller. Synthesis of the selective  
bladder carcinogen, N-(n-butyl)-N-(3-carboxypropyl) nitrosamine (BCPN).  
Org. Prep. Proced. Int. 9:49-52. 1977.

National Research Program 20830

SAFE PRODUCTS AND PROCESSES

This is one of three National Research Programs aimed at improving human health and safety. The purpose of the research is to provide a safer tobacco product and to eliminate the causative factor(s) of byssinosis in workers exposed to cotton dust.

NPS Contact: H. W. Hays

PACS Contact: C. Golumbic

Technological Objective 1:

Identification, control and elimination of potentially hazardous substances from raw and processed agricultural commodities.

Research Locations:

New Orleans, Louisiana  
Stoneville, Mississippi  
Raleigh, North Carolina

Selected Examples of Recent Progress:

Extraction of cotton dust for identification of byssinogenic agents - New Orleans, LA. Biological tests on some 40 samples of extracts of cotton dust have so far provided no definitive information on the identification of the agent(s) responsible for the byssinotic syndrome of persons occupationally exposed to cotton dust.

Chemical composition of cotton dust - New Orleans, LA. Studies on cotton dust indicate that it is made up of sizing, cellulose, protein and ash. Sizing includes starch, polyvinyl alcohol and/or carboxymethylcellulose.

Dose-response relationship for textile workers exposed to respirable cotton dust - Raleigh, NC. Human exposure to dust concentrations of  $0.5 \text{ mg/M}^3$  does not cause significant changes in ventilatory function in byssinotic individuals. Above  $0.5 \text{ mg/M}^3$ , there are measurable changes in  $\text{FEV}_{1.0}$ . Exposure of individuals to cotton cellulose dust is physiologically inert, thus eliminating this constituent of cotton dust as a causative agent.

Removal of harmful products through culture, curing and other treatments - Beltsville, MD. Techniques have been developed for removing Fraction 1 and Fraction 2 protein employing the homogenized leaf-curing process. Several thousand pounds of deproteinized tobacco have been produced for further evaluation.



Nutritional value of Fraction 1 and 2 protein - Beltsville, MD.

Preliminary animal nutritional studies indicate their PER values to be highly satisfactory. Their amino acid composition is equivalent to that of milk.

Phytosterols in tobacco and smoke - Oxford, NC and Athens, GA. Phytosterols serve as precursors of polynuclear aromatic hydrocarbons (PAH) which may contribute to the carcinogenicity of tobacco. Studies show that these can be reduced by breeding.

Presence of polonium (Po) in tobacco - Beltsville, MD. Recent studies show that Po-210 is transferred from leaf to smoke at the rate of 15 percent, irrespective of its level in the leaf. If necessary, Po could be removed from tobacco by the HLC process.

Harvest cotton before maturity to eliminate dust - Stoneville, MS. Since it is generally assumed that the bract provides the source of cotton dust during harvesting and processing, elimination of the bract by harvesting at an earlier stage of maturing might eliminate the dust and possibly the causative factor of byssinosis. Studies are now underway but it is too early to say whether this technique will eliminate the problem of byssinosis.

Technological Objective 2:

Eliminate undesirable constituents in tobacco that contribute to pulmonary and cardiovascular disease in humans.

Research Locations:

Beltsville, Maryland  
Athens, Georgia  
Oxford, North Carolina  
Buffalo, New York

Selected Examples of Recent Progress:

Identification of arenes (PAH) and aza-arene (N-PAH) - Athens, GA.  
A new method has been developed for the identification of carbazoles and benzocarbazoles in cigarette smoke condensate. Several hundred compounds were identified. Examination of these low molecular weight polynuclear aromatic hydrocarbons allows predictions to be made on the biological activity of cigarettes containing these compounds.

Bioassay of smoke condensates - Athens, GA. The mouse skin bioassay which has been widely used as a means of detecting the potential carcinogenicity of environmental chemicals was not, in this instance, sensitive enough to detect significant differences between any of the smoke condensates.

SELECTED PUBLICATIONS

Beltsville, Maryland

Harley, N. H., B.S. Cohen, and T. C. Tso. Po-210 in tobacco. In Public Health Aspects of Radioactivity in Consumer Products. 1977. (Ed. by A. A. Moghissi and P. Paras, Georgia Institute of Technology.)

Tso, T. C. Tobacco as potential food source and smoke material. Beitrage zur Tabakforschung 9(2):63-66. 1977.

Tso, T. C. and J. F. Chaplin. Simple correlation and multiple regression among leaf characteristics, smoke components, and biological response of bright tobaccos. USDA-ARS. Tech. Bull. No. 1551, 135 pp. 1977.

Tso, T. C. Tobacco and tobacco smoke. In Nightshade Crops and Health Problems. 1977. (Ed. by Norman Childers and G. Russo, Somerset Press, Inc., Somerville, N.J.).

Tso, T. C. and H. Chu. The fate of fatty compounds and surfactants used as sucker control agents on field tobacco. Beitrage zur Tabakforschung 9(2):58-62. 1977.

New Orleans, Louisiana

Battigelli, M. C. and J. J. Fischer. Controlled human exposures to "cotton" dust. Proc., Special Session on Cotton Dust, 1977 Beltwide Cotton Prod. Res. Conf., pp. 73-75. 1977. (P. J. Wakelyn and P. E. Sasser, Eds., Nat. Cotton Council of America, Memphis, TN).

Battigelli, M. C., L. P. Craven, J. J. Fischer, P. R. Morey, and P. E. Sasser. The role of histamine in byssinosis. Environ.Sci. Health A12(7):327-339. 1977.

Brown, D. F., J. H. Wall, R. J. Berni, and V. W. Tripp. Chemical composition of dusts generated during cotton processing. Proc., Special Session on Cotton Dust, 1977 Beltwide Cotton Prod. Res. Conf., pp. 55-57. 1977. (P. J. Wakelyn and P. E. Sasser, Eds., Nat. Cotton Council of America, Memphis, TN).

Wakelyn, P. J., D. F. Brown, and G. A. Greenblatt. Chemical composition of cotton bracts. Proc., Special Session of Cotton Dust, 1977 Beltwide Cotton Prod. Res. Conf., pp. 52-54. 1977. (P. J. Wakelyn and P. E. Sasser, Eds., Nat. Cotton Council of America, Memphis, TN).

Athens, Georgia

Ellington, J. J., P. F. Schlotzhauer, and A. I. Schepartz. Quantitation of tobacco lipids: Analysis of serial samples of flue-cured tobacco. Proc., Amer.Chem.Soc. Symposium, "Recent Advances in the Chemical Composition of Tobacco and Tobacco Smoke, New Orleans, LA., pp. 255-258. 1977.

Ellington, J. J., P. F. Schlotzhauer, and A. I. Schepartz. Quantitation of hexane-extractable lipids in serial samples of flue-cured tobaccos. J.Agr.Fd.Chem. 26:270-273. 1978.

Lillard, H. S. Microbiological characterization of water for recycling in poultry processing plants. J.Fd.Sci. 42:168-171. 1977.

Lillard, H.S. Effect of freezing on incidence and levels of Clostridium perfringens in mechanically deboned chicken meat. Poul.Sci. 56:2052-2055. 1977.

Mottola, A. C. Diffusivities streamline wet scrubber design. Chem.Eng. 84(27):77-80. Dec. 19, 1977.

Newman, J. O., J. W. Simons, and B. C. Haynes. Effect of furnace output and operation on temperature uniformity in a prototype research house. USDA-ARS. Tech. Bull. No. 1560. Apr. 1977.

Schepartz, A. I. and D. G. Bailey. Detection of protein in highly pigmented tobacco. Proc., Amer.Chem.Society Symposium, Recent Advances in the Chemical Composition of Tobacco and Tobacco Smoke, New Orleans, LA, pp. 104-115. 1977.

Schlotzhauer, W. S. Fatty acids and phenols from pyrolysis of cocoa powder, A tobacco product flavorant. Tob.Sci. XXII:1-2. 1978.

Sehgal, C. B. and J. J. Hutton. Homogenates of pregnant rat and fetal tissues metabolize carcinogens to mutagens detected by Salmonella Typhimurium TA98 and TA100. Mutation Res. 46:325-344. 1977.

Snook, M. E., R. F. Arrendale, H. C. Higman, and O. T. Chortyk. Isolation of indoles and carbazoles from cigarette smoke condensate. Anal. Chem. 50(1):88-90. 1978.

Walters, D. B. Monitoring phenolics in cigarette smoke condensate by micro-plyamide thin-layer chromatography. Proc., Amer.Chem.Soc.Symposium, Recent Advances in the Chemical Composition of Tobacco and Tobacco Smoke, New Orleans, LA., pp. 584-592. 1977.



National Research Program 20840

NATURAL TOXICANTS AND MICROBIAL TOXINS

This is one of three National Research Programs aimed at improving human health and safety. The purpose of the research is to provide information on the occurrence of environmental contaminants in food and feed; develop new and/or improved technologies for determining the presence of nitrosamines in foods as a result of adding nitrites during the curing process.

NPS Contact: H. W. Hays

PACS Contact: C. Golumbic

Technological Objective 1:

Assess the health hazards of toxicants occurring naturally in food and feed.

Research Locations:

Albany, California  
Peoria, Illinois  
New Orleans, Louisiana  
Wyndmoor, Pennsylvania

Selected Examples of Recent Progress:

Interaction of phytophthora infestans with potato tuber - Wyndmoor, PA. A sesquiterpene stress metabolite (SSM)  $C_{17}H_{22}O_2$  has been isolated from potato tuber slices inoculated with phytophthora infestans. These studies suggest that stress metabolites are synthesized via the cyanide-resistant respiratory pathway. Large-scale production of potato tuber stress metabolites is underway to assess their toxicological properties. One stress metabolite, katahdinone has been tested for teratogenicity and found to be negative.

Assess the factors that influence glycoalkaloid composition and content of potato tubers - Wyndmoor, PA. Glycoalkaloid levels in potatoes are significantly reduced by boiling, microwave cooking or deep-fat frying. The total glycoalkaloid (TGA) lost from the tuber after boiling can be recovered in the water. The fate of TGA in the other cooking processes has not yet been determined.

Cattle-feeding studies with crambe for FDA approval - Peoria, ILL. Thirty cattle were fed 153 days on a ration containing enough crambe meal (6.3 percent) to increase the dietary protein to 10.3 percent. The crambe addition resulted in a nonsignificant increase in rate of gain (7.2 percent) and improvement in feed conversion (3.7 percent) over the low-protein controls.

Survey of glucosinolate content of vegetables from Cruciferae family - Peoria, ILL. Twenty-nine additional varieties of cabbage were surveyed for glucosinolate content. Glucosinolates of white cabbage (Brassica oleracea) yield predominantly 3-carbon aglucons; red cabbage (Brassica oleracea), 4-carbon aglucons; Chinese cabbage (Brassica campestris) 5-carbon aglucons.

Isolation of specific hydrolysis products from aglucons of gluconsinolates for determining biological activity - Peoria, ILL. Goitrin, cyanohydroxybutene, cyanohydroxyepithiobutene, and epiprogoitrin show no evidence of being teratogenic in rats.

Hydrolysis products formed from glucosinolates in cabbage during fermentation of cabbage to sauerkraut - Peoria, ILL. Glucosinolates are completely hydrolyzed following one week of fermentation. Further studies are still in progress.

Determine the effect of selected germplasm variation and growing conditions of the amount and composition of volatile oils in carrot roots - Peoria, ILL. A toxic constituent of volatile carrot oil, myristicin has been measured in six cultivars from one location and the concentration ranged from 0.7 to 7.1 ppm of fresh carrot tissue.

Determine the metabolites of solanidine - Albany, CA. Tritiated metabolites of solanidine-<sup>3</sup>H from Phytophthora infestans -- isolated and purified by thin-layer chromatography were identified by mass spectrometry. Previously reported products of oxidation in ring A were noted but a new metabolite is being analyzed further by NMR to determine its structure.

Develop improved methodology for determining furanoterpenoid toxins in sweetpotatoes - New Orleans, LA. Extraction of sweetpotatoes with methanol-aqueous salt solution, purification on a small florisil column and separation of toxins by high performance liquid chromatography (HPLC) gave excellent results for identification of furanoterpenoids. No toxins were found in the healthy tissue of diseased potatoes even after cooking.

Assay legumes, such as southern peas and lima beans for volatile toxic compounds - New Orleans, LA. Using a modified GLC/MS technique, 38 samples of cowpeas and 19 samples of dried legumes were analyzed for potentially toxic substances. Among the compounds identified were: carbontetrachloride, acetonitrile, dimethylsulfide, carbondisulfide, chloroform, benzene, toluene, dichlorobenzene, trichlorobenzene, naphthalene and dimethylnaphthalene.

Toxicology of freeze-dried orange peel or juice puree in rats - Weslaco, TX. Rats fed a diet of 30 percent freeze-dried orange peel or juice puree did not increase the incidence of tumors from those commonly observed in rats of the test strain and were not associated with any of the dietary regimens.

Technological Objective 2:

Identify, control or eliminate mycotoxins and toxigenic fungi from food and feed.

Research Locations:

Beltsville, Maryland  
Wyndmoor, Pennsylvania  
Athens, Georgia  
Albany, California

Selected Examples of Recent Progress:

Microbial quality of deboned cooked meat - Beltsville, MD. The microbial count of hand-boned fowl was significantly lower than mechanically-deboned fowl when fecal coliforms, Escherichia coli, coliforms and aerobes were enumerated. A two to three log reduction was obtained by heating the packaged mechanically-deboned fowl in 180° F. water to an internal temperature of 160° F.

Transport of perishable food samples for microbial analysis - Beltsville, MD. Samples shipped in appropriate pre-chilled containers with dry ice as the temperature controllant gave significantly higher survival rate of Clostridium perfringens vegetative cells in ground meat as compared to samples in containers using a formulated eutectic salt mixture as temperature controllant. Mixing samples with buffered solutions of dimethylsulfoxide or glycerol prior to freezing improved the survival of all microorganisms.

Reduce Salmonellae and fecal contamination in swine and resultant pork - Beltsville, MD. Swine trailer and pens sanitized with hypochlorite show a much lower level of Salmonella contamination but E. coli remains the same as controls. Rectal swab samples taken prior to slaughter or those taken on arrival at the plant approximated those from the pen droppings. Isolation of Salmonella from the cecum were higher than from the rectum, suggesting that the cecum might be the best location for sampling for Salmonella.

Destruction of Staphylococcus aureus in fermented sausage - Wyndmoor, PA. In sausage containing both glucose and lactic acid bacteria starter culture and allowed to ferment at 35° C, the extent of injury to S. aureus was found to be inversely related to glucose concentration.

Investigate the use of acidulants to prepare "fermented" sausages - Wyndmoor, PA. To produce fermented sausages, meat with lactic acid bacteria is stuffed into casings and allowed to ferment at 25° - 35° C. until the pH falls to 5 or below. However, most foodborne bacteria grow well at 25-35° C. Since foodborne bacteria do not grow at higher temperatures, direct acidification at 55° C. was used to produce sausages similar to summer sausage. With certain modifications, such a procedure may offer the processor a means of preventing the growth of food poisoning bacteria in fermented sausage.



Safety of home-canned tomatoes - Wyndmoor, PA. Tomato acidity data obtained by USDA indicated that a few varieties and certain growing conditions yield tomatoes low enough in acidity to potentially support the growth of Clostridium botulinum. The addition of 1/4 teaspoon of citric acid or 1 tablespoon of bottled lemon juice per pint jar of tomatoes will adequately increase product acidity without adversely affecting taste. Acidulation is no substitute for the use of safe canning methods.

Effect of various nutritional and environmental conditions during growth on the heat resistance of Salmonella and/or Arizona - Albany, CA.

Bacterial cells grown with carbon as the limiting nutrient were more heat resistant than those grown with either nitrogen or phosphorus as the limiting nutrient. In all cases, the slower the growth rate, the higher the heat resistance of the cells. Bacterial cells were quite heat sensitive as long as substrate was available. As substrate diminishes, heat resistance of the cells increases.

Sporulation of Clostridium perfringens - Albany, CA. Using a mutant strain of Clostridium perfringens and a new medium, preliminary evidence has been obtained indicating that highly phosphorylated nucleotides (HPN) accumulate during sporulation and may play a key role in sporulation.

Inhibition of staphylococcal enterotoxin production in ground beef combined with texturized vegetable proteins - Athens, GA. Cooked beef products containing 20 percent of either soy protein concentrate (SPC) or texturized soy protein (TSP) produced less enterotoxin B (SEB) than in either an all-beef product (control) or beef containing 20 percent isolated soy protein (ISP). Apparently bacterial spores, indigenous to some soy protein, germinate during cooking beef-soy products and during incubation, multiply and inhibit the production of SEB.

Effect of soy proteins on the sporulation of Clostridium perfringens in ground meat products under aerobic and anaerobic conditions - Athens, GA. Sporulation in chicken thigh meat or beef, supplemented with soy protein concentrate or textured soy protein (TSP) inoculated with C. perfringens and autoclaved at 37° C., was significantly lower than in all-chicken or all-beef controls. Sporulation in chicken, beef or pork sausage was not significantly different in sample incubated aerobically or anaerobically.

Technological Objective 3:

Identify, control and/or eliminate food poisoning bacteria and bacterial toxins from food and feed.

Research Locations:

Wyndmoor, Pennsylvania  
New Orleans, Louisiana  
Peoria, Illinois  
Albany, California

Tifton, Georgia  
Raleigh, North Carolina  
Manhattan, Kansas  
College Station, Texas

Selected Examples of Progress:

Fate of patulin in fruit juices - Wyndmoor, PA. There have been conflicting reports about the presence of patulin in fermented apple beverages. Four fermentation processes were examined, using 8 strains of yeast and 15 ppb added <sup>14</sup>C labeled patulin. The fermentation procedures resulted in complete destruction of patulin. Products formed from patulin during fermentation of apple juice to hard cider were nonvolatile, water soluble substances that could be separated by TLC into at least four fractions.

Survey of wheat and corn in Midwest - Peoria, IL. The Statistical Reporting Service, USDA, collected 909 samples of corn and shipped it to the Peoria laboratory for analysis. Of the 909 samples, only 6 had detectable levels of aflatoxin; three of these were above the FDA guidelines of 20 ppb. Samples collected represented the following percentage of state corn-harvested acreage: Illinois, 77 percent; Kansas, 47 percent; Missouri, 30 percent; Nebraska, 85 percent; Ohio, 90 percent; and Wisconsin 92 percent. A survey of 238 corn samples freshly harvested in 1977 from 20 North Carolina counties, revealed an incidence of 79 percent detectable aflatoxin and 50 percent incidence of samples containing 20 or more ppb. Six percent of the samples had more than 500 ppb. In a survey of Virginia corn and wheat, no aflatoxin, zearalenone or ochratoxin were found in wheat but there was a 32 percent of aflatoxin ( $\geq 20$  ppb) in corn.

Survey of corn for sterigmatocystin - Peoria, IL. No sterigmatocystin was detected in 222 samples of corn collected in South Carolina, but 51 percent of these samples had aflatoxin. Corn contaminated with sterigmatocystin at levels of 1000, 600 and 70 ppb was allowed to stand at room temperature for 17 days to 6 months. The two highest levels had 53 and 63 percent of the original toxin after six months but there was no evidence of loss at the lowest level.

Find corn hybrids resistant to zearalenone formation - Peoria, IL. Nonsterile corn hybrids and inbreds were inoculated in the laboratory with three Fusarium graminearum isolates, fermented and analyzed for zearalenone. One single cross hybrid provided a significantly better substrate for zearalenone than the others. There was evidence that one of the inbred in the cross was responsible for the hybrids' susceptibility to zearalenone formation. In the field study, it was found that

zearalenone was highest when ears were inoculated by injecting Fusaria in the silk at the time of silking. Inoculating in the same manner 2 and 3 weeks after silking resulted in no detectable zearalenone.

Zearalenone in products from corn oil refining - Peoria, IL. Zearalenone was determined in products from refining contaminated corn oil. No zearalenone was detected in refined oil obtained from crude oil containing 300 ug/100 ml of the mycotoxins.

Detoxification of approximately 20 metric tons of aflatoxin-contaminated corn for use in cattle feeding trials - Peoria, IL. Corn contaminated with high levels of aflatoxin (ca 1200 ppb) could not be found in field samples, thus making it necessary to produce contaminated corn artificially. Corn was inoculated with Aspergillus flavus and under proper conditions of moisture and temperature, produced aflatoxin to a level of 1200 ppb. Half of the sample was retained for feeding (control) while the other half was treated with 1.5 percent gaseous ammonia and held for 14 days. Aflatoxin content of corn after treatment averaged less than 6.0 ppb. The detoxified corn, along with good corn, ammoniated good corn and contaminated corn was shipped to Clemson University for beef cattle feeding studies.

Roasting corn as a means of lowering aflatoxin - Peoria, IL. Aflatoxin-contaminated corn was processed in a roaster under a variety of conditions. Direct roasting of corn reduced aflatoxin content about 60-70 percent; addition of 0.5 ammonia to the corn and holding it for 3 hours gave better results.

Determine dosage of vomitoxin required to elicit refusal and vomiting in swine - Peoria, IL. Levels of T-2 toxin on corn at 2 ppm, 10 ppm, 20 ppm, and 40 ppm were fed to swine. Over a 24-hour period swine accepted only 40 percent of the corn containing 10, 20, and 40 ppm T-2. Corn fed swine at 5 ppm vomitoxin did not cause vomiting but a refusal response caused an average weight loss of 2.9 kg.

Develop procedures for detection of specific fungal components as measures of extent of invasion, mycotoxin and other fungal metabolites - Manhattan, KS. A high pressure liquid chromatographic method was developed for determination of ergosterol, a predominant sterol component of most fungi, in grains and culture media. Ergosterol assay was used to measure extent of preharvest fungal invasion in grain sorghum, wheat and corn. Ergosterol content and percentage of kernels with fungi increased in sorghum. Assay of wheat samples showed a close relation between level of ergosterol and invasion by field fungi and with weather conditions known to favor fungal invasion. Corn kernels with obvious fungal damage had 200 ug/gram ergosterol, while freshly harvested sound kernels contained only about 0.2 ug/gram.



Develop methodology for accurate and precise determination of aflatoxins in food and feed ingredients - New Orleans, LA. A silica gel-packed flowcell for the fluorescence detection of aflatoxin B<sub>1</sub>, B<sub>2</sub>, G<sub>1</sub>, and G<sub>2</sub> after their resolution by HPLC on a microparticulate silica gel column, shows promise for more sensitive and reliable measurement of aflatoxins. An HPLC method was developed for determination of aflatoxin in corn, the major ingredients in mixed feeds.

Characterize major inactivation compounds produced by model ammoniation of aflatoxins B<sub>2</sub> and G<sub>1</sub> - New Orleans, LA. The major product of ammoniation of pure B<sub>2</sub> has a mw of 288. Ammoniation of G<sub>1</sub> yielded a compound chromatographically to the mw 206 compound formed from B<sub>1</sub>. The ammoniated products (mw 286 and 206) cause fewer tumors in trout than does aflatoxin B<sub>1</sub>.

Initiate development of methodology for detecting mycotoxins, other than mycotoxins which may be potential hazards in peanuts and cottonseed - New Orleans, LA. A multimycotoxin high performance liquid chromatographic (HPLC) method for determining zearalenone, sterigmatocystin, ochratoxin A, penicillic acid and citrinin in peanuts has been essentially completed. The method is sensitive to 20 ppb or less, except for citrinin and penicillic acid.

Demonstrate safety of meat and eggs from hens fed ammonia-detoxified cottonseed meal - New Orleans, LA. Phase II of the feeding study with rats has been essentially completed. During this study rats were fed diets of which 20 percent were comprised of cooked freeze-dried eggs or tissues from hens that had been fed cottonseed meal (CSM), ammoniated cottonseed meal (ACSM) aflatoxin-contaminated cottonseed meal (CCSM) and ammoniated detoxified cottonseed meal (ADCM) under Phase I experiment. The findings of these studies will be reported to the Food and Drug Administration in support of USDA's request to use aflatoxin-decontaminated cottonseed meal as feed for poultry.

Further studies on inactivation of aflatoxin in cottonseed meal by ammoniation with minimal loss of nutritional quality - New Orleans, LA. Studies using 3 percent, 4 percent and 5 percent ammonia were carried out at temperatures of 150° F. to 200° F. Ammonia pressures attained, 22 psig to 50 psig, varied with concentrations and temperatures. Such a process is capable of reducing aflatoxin-contaminated cottonseed meal from several hundred parts per billion to less than five parts per billion.

Postharvest mycoflora of pecans and the identification of metabolites College Station, TX. Zearalenone, alternariol, alternariol-monomethyl-ether and sterigmatocystin were found in in-shell pecans but the level and incidence was very low. These data support the theory that aflatoxin contamination is the only mycotoxin contaminant that is a serious threat to health.

Resistance to postharvest invasion by aflatoxin producing fungi in pecans - College Station, TX. In-shell resistance to aflatoxin contamination was studied in 23 cultivars from 4 locations. Two thousand, seven hundred and ninety-five (2795) individual kernels were analyzed after 21 days of exposure to high populations of mixed Aspergillus flavus and Aspergillus parasiticus. Average aflatoxin contamination ranged from 0 - 170,000 ppb/sample. The most susceptible cultivars were: Choctaw, Desirable, and Success (College Station); Cope Fear (Louisiana); Success and 55-12-17 (Brownwood, TX).

Characterize fungi associated with postharvest deterioration of field crops in North India - College Station, TX. Studies were made of 212 samples of various seeds collected between April and May. Seeds of cereals were found to have the highest colonization percentages while the lowest was found in black mustard. Species of the Aspergilli and Penicillia were most commonly isolated.

Develop screening methods for mycotoxins in oilseed and cereal grains - Dawson, GA. A minicolumn method was developed for the identification of aflatoxins, ochratoxin A and zearalenone for a variety of agricultural products. The sensitivity of the method is 4 ppb for aflatoxins, 8 ppb for ochratoxin A, and 25-50 ppb for zearalenone.

Characterize the microflora and their metabolites affecting peanuts and other commodities - Dawson, GA. Studies have been completed on the structure and biosynthesis of versiconal acetate, an important biosynthetic precursor to aflatoxins.

"Paspalum staggers" a neurological disease in cattle - Dawson, GA. Three tremorgenic metabolites were isolated and chemically characterized from a fungus, Claviceps paspali, which is believed to be responsible for a neurological disease in cattle, called "paspalum staggers".

Isolation of mycotoxins from Aspergillus fumigatus - Dawson, GA. Tests with crude extracts of A. fumigatus produced neurological signs in cattle similar to those seen in field cases. The fungus produced several tremorgenic mycotoxins believed to be responsible for abnormal behavior seen in field outbreaks.

A new trichothecene from Fusarium tricinctum - Dawson, GA. A new mycotoxin was isolated from F. tricinctum found growing on peanuts remaining in the soil after harvest. The toxin was shown to be 3 $\beta$ -hydroxy-4 $\beta$ , 8 $\alpha$ , 15-triacetoxy-12,13-epoxytrichothec-9-ene and given the trivial, neosolaniol monoacetate. The mean lethal dose in one-day-old chicks was 0.78 mg/kg and possessed similar dermal toxicity to T-2 toxins in rabbits.



Determine variances associated with sampling, subsampling and analysis of corn for aflatoxin and develop a feasible testing program - Raleigh, NC. Sampling, subsampling and analytical variables increase with an increase in aflatoxin concentration. At 20 ppb aflatoxin, the coefficient of variation associated with a 4.54 kg sample, 1 kg sample and the analysis of one aliquot (CB method) was 20, 2, and 32 percent respectively.

Test the accuracy of the BGY fluorescent test as a rapid method to detect aflatoxin in corn produced in the Southeast - Raleigh, NC. A high correlation ( $R = .95$ ) was found between the percent by weight of BGY kernels and the concentration of aflatoxin in 371 samples of corn.

Develop a method to reduce the cost associated with solvent extraction of large subsamples of comminuted peanuts for aflatoxin analysis - Raleigh, NC. Aflatoxin was extracted by the water-slurry method from (20) 1100 gm subsamples and compared to the amount of aflatoxin extracted by the standard USDA procedure for another (20) 1100 gm subsamples. More aflatoxin was extracted by the water-slurry than by the USDA method. The difference was significant at the 5 percent level but not at the 1 percent.

Toxicity studies on ammoniated corn to laying hens - Clemson, SC. Laying hens were fed ammoniated aflatoxin-contaminated corn, aflatoxin-contaminated corn, good corn and ammoniated good corn. No significant differences were observed among the hens on the four diets with respect to fertility, hatchability, body weights, egg production, shell thickness, and feed conversion. No teratological effects were observed.

Determine controlling factors of fungal growth in poultry feed and mycotoxin production - Athens, GA. The growth of fungi on mixed feed was quantitatively determined by the chitin procedure using Aspergillus ochraceus and its toxin, ochratoxin A as a model. The maximum amount of ochratoxin A is produced on poultry feed after maximum growth has occurred (95 percent moisture and 30° C). Gentian violet, a fungal inhibitor formerly used in poultry feed to prevent fungal growth, was only fungistatic, allowing enough growth to produce lethal levels of ochratoxin A.

Feeding studies in rats of ammoniated aflatoxin-contaminated corn - Athens, GA. In Phase II of the USDA-FDA protocol for determining the safety of aflatoxin decontaminated corn, rats were fed diets containing meat from poultry and pork which had been fed diets containing aflatoxin-decontaminated corn. No diet related differences in weight gain ratios, growth curves, conceptions, live vs. dead births, litter weights, fetal abnormalities or any related parameters in the F<sub>1b</sub> and F<sub>2a</sub> generations. Of the rats which died or were sacrificed, there were no diet-related differences in organs and tissues subjected to histological examination.

Feeding studies in beef cattle of ammoniated aflatoxin-contaminated corn - Athens, GA. Phase I of USDA-FDA protocol required feeding ammoniated aflatoxin-contaminated corn to beef cattle. This work has been completed. No adverse effects were noted in any of parameters used for detecting toxicity. Phase II of the study has not been initiated because of inadequate staffing.



Culture of fungi of the clavicipitaceae family and determine mycotoxin production and biological effects - Athens, GA. Several endophytic fungal pathogens of grasses (Balansia sp., Myriogenospora atrementosa, and Epichloe typhina) found in pastures where cattle had developed ergot-like syndromes (e.g. convulsions, gangrene, reproductive problems) have been cultured on laboratory media and shown to produce compounds analogous to those produced by the other Clavicipitacea. Epichloe typhina has been observed on all samples of toxic fescue and laboratory studies indicate that there are biotypes of this fungus which might be involved in the fescue toxicity syndrome. Indole alkaloids from Balansia species proved toxic to chicken eggs. Ergot alkaloids (Chanoclavine) have been isolated from laboratory cultures of two species of Balansia. Reproduction problems, previously of undefined causes, in livestock have been observed in pastures infected by the above fungi. Alkaloids of the clavine-type (Chanoclavine) produced by Claviceps are known to cause the identical syndrome.

SELECTED PUBLICATIONS

Beltsville, Maryland

Childers, A. B., E. E. Keahey and A. W. Kotula. Reduction of Salmonella and fecal contamination of pork. J. Amer. Vet. Med. Assoc. 171:1161-64. 1977.

Emswiler, B. S., C. J. Pierson, and A. W. Kotula. Comparative study of two methods for detection of Clostridium perfringens in ground beef. Appl. & Environ. Micro. 33:735-737. 1977.

Field, R. A., F. C. Smith, D. D. Deane, G. M. Thomas, and A. W. Kotula. Sources of variation at the retail level in bacteriological condition of ground beef. J. Food Protection 40(6):385-388. 1977.

Whitaker, T. B., and M. E. Whitten. Evaluation of cottonseed aflatoxin<sup>1</sup> testing programs. J. Amer. Oil Chem. Soc. 54(10):436-441. 1977.

Philadelphia, Pennsylvania

Allen, J. R., R. J. Marlar, C. F. Chesney, J. P. Helgeson, A. Kelman, K. G. Weckel, E. Traisman, and J. W. White, Jr. Teratogenicity studies on late blighted potatoes in nonhuman primates (Macaca Mulatta and Saguinus Labiatus). Teratology 15:17-24. 1977.

Bills, D. D. Interactions between Phytophthora infestans and potato host. In Host Plant Resistance to Pests, pp. 47-60. 1977. Ed. by Paul A. Hedin. (Am.Chem.Soc. Symp. Series No. 62, Washington, D.C.)

Fitzpatrick, T. J., S. F. Herb, S. F. Osman, and J. A. McDermott. Potato glycoalkaloids: Increases and variations of ratios in aged slices over prolonged storage. Amer.Potato. Jour. 54:539-544. 1977.

Osman, S. F. and S. L. Sinden. Analysis of mixtures of solanidine and demissidine glycoalkaloids containing identical carbohydrate units. J. Agr. and Fd. Chem. 25:955-957. 1977.

Palumbo, S. A., M. Komanowsky, V. Metzger, and J. L. Smith. Kinetics of pepperoni drying. J. Fd. Sci. 42:1029-1033. 1977.

Palumbo, S. A., J. L. Smith and J. C. Kissinger. Destruction of Staphylococcus aureus during frankfurter processing. Applied and Environmental Microbiol. 34:740-744. 1977.

Sapers, G. M., J. G. Phillips, and A. K. Stoner. Tomato acidity and the safety of home canned tomatoes. HortScience 12(3):204-208. 1977.

Smith, J. L., Huhtanen, C. N., J. C. Kissinger, and S. A. Palumbo. Destruction of Salmonella and Staphylococcus during processing of a nonfermented snack sausage. J. Fd. Protection 40:465-467. 1977.

Stinson, E. E., C. H. Huhtanen, T. E. Zell, D. P. Schwartz, and S. F. Osman. Determination of patulin in apple juice products as the 2,4-dinitrophenylhydrazine derivative. J. Agr. Fd. Chem. 25:1220-1222. 1977.

Zacharius, R. M. and S. F. Osman. Glycoalkaloids in tissue culture of Solanum species. Dehydrocommersonine from culture roots of Solanum Chacoense. Plant Sci. Ltr. 10:283-287. 1977.

#### Peoria, Illinois

Brekke, O. L., R. D. Sinnhuber, A. J. Peplinski, J. H. Wales, G. B. Putnam, D. J. Less, and A. Ciegler. Aflatoxin in corn: Ammonia inactivation and bioassay with rainbow trout. Appl. Environ. Microbiol. 34:34-37. 1977.

Chi, M. S., C. J. Mirocha, H. J. Kuntz, G. Weaver, F. Bates, W. Shimoda, and H. R. Burmeister. Acute toxicity of T-2 toxin in broiler chicks and laying hens. Poultry Sci. 56:103-116. 1977.

Fennell, D. I., Kwolek, W. F., E. B. Lillehoj, G. L. Adams, R. J. Bothast, M. S. Zuber, O. H. Calvert, W. D. Guthrie, A. J. Bockholt, A. Manwiller, and M. D. Jellum. Aspergillus flavus presence in silks and insects from developing and mature corn ears. Cereal Chem. 54:770-778. 1977.

Shotwell, O. L. Aflatoxin in corn. J. Amer. Oil Chem. Soc. 54:216-A-224-A. 1977.

Shotwell, O. L. and M. L. Goulden. Aflatoxin: Comparison of analyses of corn by various methods. J. Assoc. Offic. Anal. Chem. 60:83-88. 1977.

Vesonder, R. F., A. Ciegler, and A. H. Jensen. Production of refusal factors by Fusarium strains on grains. Appl. Environ. Microbiol. 34:105-106. 1977.

#### Manhattan, Kansas

Seitz, L. M. and H. E. Mohr. A new method for quantitation of aflatoxin in corn. Cereal Chem. 54:179. 1977.

Seitz, L. M., H. E. Mohr, R. Burroughs, and D. B. Sauer. Ergosterol as an indicator of fungal invasion in grains. Cereal Chem. 54:1207. 1977.

#### Albany, California

Heftmann, E. Functions of steroids in plants. In Progress in Phytochemistry 4:257-276. 1977. (Pergamon Press, New York).

Sacks, L. E. and P. A. Thompson. Increased spore yields of Clostridium perfringens in the presence of methylxanthines. Appl. Environ. Microbiol. 189-193. 1977.

Sacks, L. E. and P. A. Thompson. A clear, defined medium for the sporulation of Clostridium perfringens. Abstracts. 7th Int. Spore Conf. 1977.



New Orleans, Louisiana

Trucksess, M. W., L. Stoloff, W. A. Pons, Jr., A. F. Cucullu, L. S. Lee, and A. O. Franz, Jr. Thin layer chromatographic determination of aflatoxin B<sub>1</sub> in eggs. J.Assoc. Offic.Anal.Chemists 60:795-798. 1977.

Pons, W. A., Jr. Symposium Chairman: Aflatoxins in Oilseeds - problems and solutions. J.Amer.Oil Chem.Soc. 54:215A-249A. 1977.

College Station, Texas

Schroeder, H. W., and R. J. Cole. Natural occurrence of alternariols in discolored pecans. J.Agric.Food Chem 25:204-206. 1977.

Schroeder, H. W., and J. B. Storey. Sound shells reduce aflatoxin contamination of pecans. Pecan Quarterly 11(1):17. 1977.

Schoreder, H. W. and H. Hein, Jr. Natural occurrence of sterigmatocystin in in-shell pecans. Can. J. Microbiol.23:639-641. 1977.

Dawson, Georgia

Cole, R. J., J. W. Kirksey, J. W. Dorner, D. M. Wilson, J. C. Johnson, Jr. A. N. Johnson, D. M. Bedell, J. P. Springer, K. K. Chexal, J. C. Clardy and R. H. Cox. Mycotoxins produced by Aspergillus fumigatus species isolated from molded silage. J. Agric. Fd. Chem. 25:826-830. 1977.

Cole, R. J., J. W. Dorner, J. A. Lansden, R. H. Cox, C. Pape, B. Cunfer, S. S. Nicholson and D. M. Bedell. Paspalum staggers: Isolation and identification of tremorgenic metabolites from sclerotia of Claviceps paspali. J.Agric.Food Chem. 5:1197-1201. 1977.

Cox, C. H., F. Churchill, R. J. Cole and J. W. Dorner. Carbon-13 nuclear magnetic resonance studies of the structure and biosynthesis of versiconal acetate. J.Amer.Chem.Soc. 99:3159-3161. 1977.

Cox, R. H. and R. J. Cole. Carbon-13 nuclear magnetic resonance, studies of fungal metabolites, aflatoxin and sterigmatocystins. J.Organic Chem. 42: 112-114. 1977.

Lansden, J. A. A cleanup procedure for HPLC analysis of aflatoxins in agricultural commodities. J.Agric.Food Chem. 25:969-971. 1977.

Lansden, J. A., R. J. Cole, J. W. Dorner, R. H. Cox, H. G. Cutler, and J. D. Clark. A new trichothecene mycotoxin isolated from Fusarium tricinctum. J.Agric.Food Chem. 26:246-248. 1978.

Schroeder, H. W. and R. J. Cole. Natural occurrence of alternariols in discolored pecans. J.Agric.Food Chem. 25:204-206. 1977.

Wells, J. M. and R. J. Cole. Production of penitrem A and an unidentified toxin by Penicillium lanosocoeruleum isolated from weevil-damaged pecans. J.Phytopathology 6:779-782. 1977.

Athens, Georgia

Bacon, C. W. The growth of fungi in problem broiler houses and feed bins. (Abstract). Poultry Sci.: 1346. 1977.

Bacon, C. W. and D. Burdick. Growth of fungi in broiler houses. Poultry Sci. 56:653-661. 1977.

Bacon, C. W., J. D. Robbins and J. K. Porter. Media for identification of Gibberella zeae and production of F-2 (zearalenone). Appl. Environ. Microbiol. 33:445-449. 1977.

Bacon, C. W., J. K. Porter, J. D. Robbins, and E. S. Luttrell. Epichloe typhina from toxic tall fescue grasses. Appl. and Environ. Microbiol. 34: 576-581. 1977.

Blankenship, L. C. Attachment characteristics of Clostridium perfringens spores to broiler carcass skin. Proc., 77th Ann. Meet., Amer. Soc. Microbiol., p.245. 1977.

Cox, N. A., and A. J. Mercuri. Rapid confirmation of suspect Salmonellae colonies by use of the Minitex system in conjunction with serological tests. J.App.Bacteriol. 41:389-394. 1976.

Cox, N. A. and A. J. Mercuri. Evaluation of four ONPG tests for Enterobacteriaceae from human, animal and selected food sources. J.Food Protection 40:709-711. 1977.

Cox, N. A., F. McHan, and D. Y. C. Fung. Commercially available minikits for the identification of Enterobacteriaceae: A review. J.Food Protection 40: 866-872. 1977.

Cox, N. A., A. J. Mercuri, J. E. Thomson, and J. S. Bailey. A sensitive procedure for detecting Salmonellae on whole broiler carcasses without pre-enrichment. J.Food Protection 40:729. (Abstract). 1977.

Craven, S. E. and A. J. Mercuri. Total aerobic and coliform plate counts in beef-soy and chicken-soy patties during refrigerated storage. J.Food Protection 40:112-115. 1977.

Luttrell, E. S., C. W. Bacon. Classification of Myriogenospora in the clavicipitaceae. Can.Jour.Bot. 55:2090-2097. 1977.

Porter, J. K., C. W. Bacon, J. D. Robbins, D. S. Himmelsbach, and H. C. Higman. Indole alkaloids from Balansia epichloe (Weese). J.Agric.Food Chem. 25: 88-93. 1977.

Thomson, J. E., N. A. Cox, and J. S. Bailey. Control of Salmonella and extension of shelf-life of broiler carcasses with a glutaraldehyde product. J.Food Sci. 42:1353-1355. 1977.

ANNUAL REPORT  
FY 1977

National Research Program 20860

FAMILY USE OF RESOURCES

This National Research Program includes studies of expenditures and consumption and use of consumer goods and services, to provide information needed by families for budgeting and resource management. It relates to the Department's Program 650, "Research on Consumer Services." The overall USDA Mission relates to "Consumer Services and Human Resource Development," and has the Operating Goal "New Knowledge to Reduce Health Hazards and Improve Family Living." Thus the Mission includes a related program of research to improve human health and safety.

NPS Contact: (J. M. Iacono, Interim) PACS Contact: C. Columbic

Technological Objective 1:

Establish principles which can be used to improve family use of resources and provide educators and program leaders with sound guidance material for an improved level of living of families.

Research Locations:

Hyattsville, Maryland  
Knoxville, Tennessee

Selected Examples of Progress:

New results on the Service Life of Appliances - Hyattsville, MD. Two articles on the methodology and results of the second phase of the service life project--estimates by household characteristics--were prepared and accepted for publication. A paper describing the methodology of the entire project was presented, by invitation, at a symposium sponsored by the National Bureau of Standards. The publications and paper made the project results more serviceable to two separate audiences: Researchers who need technical information on methodology, and professionals working with families who need guidance materials.

Materials for use by professional workers disseminated - Hyattsville, MD. Seventeen articles related to the economic situations of families were written and made available to State Extension agents, high school and college teachers, social workers, and other professionals through the Institute's quarterly publication, Family Economics Review. The information is used in university classes and to develop State-oriented materials for working directly with families.



Analysis of trends in clothing expenditures - Hyattsville, MD. Presented as an Outlook paper, this analysis is used by business and professional people needing background information, and is an aid to professional workers who are developing materials on budgeting for use with families. It has been widely quoted in newspapers.

Computer programs upon several state networks - Hyattsville, MD. The revision of two computer program/teaching aids, "Can We Afford It?" and "Budgeting for Retirement," increased their usability by State Extension offices. The programs are an aid to Extension agents and other professional workers who counsel families.

Models for consumer buying, use, and care of household bedding and blankets - Knoxville, TN. An experimental test method has been devised which will predict blanket surface appearance and amount of dryer lint in the dryer filter when representative blankets are laundered. Simulated laundering effects are achieved by abrading blanket specimens in an Accelorotor abrasion instrument for a specified time period. Total weight of lint accumulated by the fourth and tenth laundering cycles can be predicted, as well as the surface appearance of blankets. This test method may prove useful to blanket retailers and consumers as indicators of blanket wear performance.

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This Annual Report was prepared by Robert L. Rizek and Frances M. Magrabi, Consumer and Food Economics Institute, Hyattsville, Maryland.

PUBLICATIONS

Hyattsville, Maryland

Edwards, C. S. Credit Unions. Family Econ. Rev. ARS-NE-36. pp. 8-11. Fall 1977.

Hoerman, C. M. Bankruptcy and its alternatives. Family Econ. Rev. ARS-NE-36. pp. 6-8. Summer 1977.

Hoerman, C. M. The management and use of credit cards. Family Econ. Rev. ARS-NE-36. pp. 8-9. Summer 1977.

Jennings, C. L. Sources of Government data useful in family economics research. Family Econ. Rev. ARS-NE-36. pp. 13-27. Spring 1977.

Jennings, C. L. and K. S. Tippet. Consumer installment credit. Family Econ. Rev. ARS-NE-36. pp. 3-7. Fall 1977.

Mork, L. M. and M. L. Cooper. A guide to budgeting for the young couple, HG 98. Revised July 1977.

Mork, L. M. and M. L. Cooper. Selecting and financing a home, HG 182. Revised September 1977.

Polyzou, A. New developments in clothing and textiles. Family Econ. Rev. ARS-NE-36. pp. 3-6. Summer 1977.

Polyzou, A. and R. Dardis. Flammability standards for sleepwear--A cost benefit analysis. Family Econ. Rev. ARS-NE-36. pp. 16-19. Fall 1977.

Polyzou, A. Clothing and textiles: supplies, prices, and outlook for 1978. Food and Agricultural Outlook Conference, Washington, D.C. 10 pp. 1977.

Ruffin, M. D. and K. S. Tippet. Household retention of consumer appliances: USDA actuarial estimates. Product durability and life: Proceedings of the 27th Meeting of the Mechanical Failures Prevention Group, held at the National Bureau of Standards, November 1-3, 1977. 8 pp. 1978.

Tippet, K. S. (Editor) Family Economics Review (quarterly). ARS-NE-36. Winter 1977 (32 pp.), Spring 1977 (36 pp.), Summer 1977 (25 pp.), and Fall 1977 (28 pp.).

Tippet, K. S., F. M. Magrabi and B. C. Gray. Service life of appliances: Variations by selected characteristics of owner households. Home Econ. Res. J. Accepted in 1977; for publication in March 1978, 6(3):182-191.

U.S. Department of Agriculture. The Consumer. (24 charts and 1 table). 1977 Handbook of Agricultural Charts. AH 524. 1977.

U.S. Senate Committee on Agriculture, Nutrition, and Forestry. 1978 U.S. Food and Agricultural Outlook Conference. (95th Congress, 1st Session). pp. 21-53, 329-361. U.S. Government Printing Office, Washington, D.C. 1977.

Knoxville, Tennessee

Jones, J. B. The effectiveness of hydroxyethyl cellulose as a partial replacement for phosphate in detergent systems. Thesis. Univ. of Tenn. Knoxville (June 1977).

Lamb, J. M. Clothing for handicapped children: Recent developments. Rehabilitation Lit. 38:278-284 (Sept. 1977).

Metcalf, P. A. Effects of temperature and water hardness on the soil-removal ability of detergent systems containing hydroxyethyl cellulose. Thesis. Univ. of Tenn., Knoxville (March 1977).

Vigo, T. L. "Antibacterial Fibers" -- In Modified Cellulosics, New York: Academic Press (Nov. 1977).



ANNUAL REPORT  
FY 1977

National Research Program 20900

FOOD COMPOSITION AND IMPROVEMENT

This National Research Program is designed to (1) produce and disseminate data on the nutrient composition of foods and (2) provide the technology for the nutritional improvement of food where needed and feasible. The program is broad in scope ranging from basic research on analytical methodology, to inhouse and contracted routine analyses, to inhouse development of new technologies for nutrient fortification, and to nutrient data publication (printed and/or computer readable media).

NPS Contact: (J. M. Iacono, Interim)

PACS Contact: C. Columbic

Technological Objective 1:

To provide accurate, up-to-date and comprehensive information to a readily usable form on the composition of all important foods for those nutrients required by and biologically useful to man.

Research Locations:

Albany, California  
Athens, Georgia  
Peoria, Illinois  
Beltsville, Maryland  
Hyattsville, Maryland

Selected Examples of Progress:

Nutrient Composition Laboratory comes of age - Beltsville, MD. Only two and one half years after its formation, the Nutrient Composition Laboratory has become a unique, research nutrient analysis facility which has few peers. The laboratory has an exceptional scientific staff and unique facilities for modern nutrient analyses. The special character of the laboratory is that it combines state of the art research on new analytical methods with the application of these methods to routine food analysis.

Zinc and copper contents of self selected diets determined - Beltsville, MD. A group of twenty-two subjects, aged 14-64, each supplied duplicate plate samples of six daily diets as eaten and kept dietary records for a fourteen day period. These total daily samples were composited and analyzed for zinc and copper content by atomic absorption spectrometry. Levels of other nutrients were calculated by computer from the dietary records.

The mean daily zinc intake was 8.6 mg/day with a range of 5.9 to 12.1 mg, and the mean copper intake was 1.0 mg/day with a range of 0.6 to 2.0 mg. These intakes are both lower than the suggested daily intakes of 15 mg for zinc and 2.0 mg for copper.

Revision of Home and Garden Bulletin No. 72 - Hyattsville, MD. The revision of Home and Garden Bulletin No. 72, "Nutritive Value of Foods," was published in April, 1977. This bulletin is for the consumer and presents nutritive values of foods in terms of household measures. This major revision was made possible by the information being acquired in revisions of the more comprehensive publication, Agriculture Handbook No. 8, "Composition of Foods...Raw, Processed, Prepared."

Agriculture Handbook 8-2 "Spices and Herbs" released - Hyattsville, MD. "Spices and Herbs," the second section of the revised Agriculture Handbook No. 8, was published in January 1977. The USDA computerized Nutrient Data Bank is operational for use in the development of the revisions of Handbook No. 8.

Brewers yeast Standard Reference Material certified for chromium - Beltsville, MD. A Standard Reference Material (SRM 1569 - Brewers Yeast) has been certified for chromium content and issued by the National Bureau of Standards in cooperation with the Nutrition Institute. This material is intended for use in calibrating instrumentation and evaluating the accuracy of analytical methods for the determination of chromium in biological materials. An international collaborative study of chromium analysis involving 12 laboratories has been carried out using this material and several previously unrecognized procedural and methodological problems have been better diagnosed. This Standard Reference Material, will have a great impact upon accuracy for determination of the content of the essential trace element chromium in foods and other biological materials.

Chemistry of dietary fibers - Peoria, IL. Effects of human gastrointestinal action upon some cereal brans incorporated into baked bread have been examined. Dry-milled corn bran is unaffected while both soft white winter wheat bran and soybean hull suffer losses of apparent hemicellulose and some cellulose. These results indicate that probably the latter two roughages are partially utilized for food by microflora in the human gut. This work was done as a cooperative effort with the Human Nutrition Laboratory (HNL), Grand Forks, North Dakota.

Lysine protection - Albany, CA. Considerable interest exists in protecting the essential amino acid, lysine, in protein products and a number of protecting agents have been proposed. However, this project has shown that many of the proposed protecting agents destroy the nutritional quality of the protein. Highly processed proteins have been shown to contain several condensed amino acid products, one of which, lysinoalanine, is toxic. An efficient means of preventing the formation of these toxic compounds has been developed.

Technological Objective 2:

To provide the technology for the nutritional improvement of foods when enhanced levels of certain nutrients in the diet are needed to correct possible dietary faults.

Research Locations:

Albany, California  
Hyattsville, Maryland  
Philadelphia, Pennsylvania

Selected Examples of Progress:

Trypsin inhibitor activity was assayed as a function of protein source, extraction, isolation, and drying parameters - Albany, CA. In general, activity was minimal in rice, wheat, and safflower byproducts and protein products.

A systematic study of the impact of protein fortification of wheat breads upon ultimate protein quality and availability was conducted using chemical and biological assays - Albany, CA. Various sources of rice bran and protein products derived from such were used as the protein sources.

A linear program was designed to evaluate the protein quality and quantity of various mixtures of cereals, legumes and other protein sources - Albany, CA.

A series of whey/soy drink powders was prepared using fluid or condensed whey, with or without the use of 0.5% added emulsifier and using single or double stage homogenization - Philadelphia, PA. All samples with Tween 60 contained less moisture and showed greater solubility index, greater sinkability, reduced dispersibility and reduced particle size compared to their non-Tween containing counterparts. All samples prepared with single stage homogenization showed unacceptable settling characteristics. In order to produce whey/soy drink whose settling characteristics meet specifications, double stage homogenization is necessary and the pressure must be greater than 126.6-35.2 kg/cm<sup>2</sup>.

Three whey-peanut beverage bases containing 20% protein and 20% fat were prepared using standard processing techniques - Philadelphia, PA. Peanut flours used were a commercial, partially defatted flour; a commercial defatted flour; and an experimental defatted flour obtained from SRRC. Determination of protein efficiency ratios of the three samples is still in progress.

This Annual Report was prepared by Walter Mertz and Kent Stewart, Nutrition Institute, Beltsville, Maryland.



PUBLICATIONS

TO 1

Albany, California

Betschart, A. A. Separation of protein isolates from safflower seeds. U.S. Patent No.: 4,072,669. 1977.

Betschart, A. A., R. V. Enochian, and R. M. Saunders. Potential for protein fortification of wheat foods in Morocco. AID Report. 1977.

Batra, K. K., J. R. Wagner, and E. L. R. Stokstad. Folic acid compounds in romaine lettuce. Can. J. Biochem. 55:865-868. 1977.

Fellers, D. A., M. M. Bean, A. A. Betschart, and R. V. Enochian. Potential for protein fortification and extension of wheat foods in Costa Rica. AID Report. 1977.

Fellers, D. A., A. A. Betschart, R. V. Enochian (with assistance of M. M. Bean, R. M. Saunders, and A. D. Shepherd). Potential for protein fortification of wheat foods in Bolivia. AID Report. 1977.

Finley, J. W. and M. Friedman. New amino acids derivatives formed by alkali treatment of proteins. In: "Protein Crosslinking: Its Nutritional and Medical Consequences" (Edited by M. Friedman) Advances in Experimental Medicine and Biology. 86B. Chapt. 8:123-130. 1977.

Finley, J. W., W. L. Stanley, and G. Watters. Removal of chill haze from beer with papain immobilized on chitin. Biotechnology and Bioengineering. 19:1895-1897. 1977.

Finley, J. W., J. T. Snow, and M. Friedman. Prevention of lysinoalanine formation in processed protein-foods. U.S. Patent Application, Serial No. 585212. 1977.

Finley, J. W., J. T. Snow, and P. H. Johnston. Inhibitory effect of mercaptoamino acids on treatment of proteins. In: "Protein Crosslinking: Its Nutritional and Medical Consequences" (Edited by M. Friedman) Advances in Experimental Medicine and Biology. 86B. Chapter 6:85-92. 1977.

Finley, J. W. and J. T. Snow. An improved synthesis of lysinoalanine amonhydrochloride. J. Agr. Food. Chem. 25:1421-1423. 1977.

Friedman, M., J. W. Finley, and L. S. Yeh. Reactions of proteins with dehydroalanines. In: "Protein Crosslinking: Its Nutritional and Medical Consequences" (Edited by M. Friedman) Advances in Experimental Medicine and Biology. 86B. Chapter 15:213-224. 1977.

Hansen, L. U. and F. T. Jones. A microscopic view of thermal-processed wheat flour. J. Fd. Sci. 42:1236-1242. 1977.

Saunders, R. M. and A. A. Betschart. Protein quality of wheat millfeed protein concentrates. J. Food Sci. 42:974-975, 981. 1977.

Peoria, Illinois

Sandstead, H. H., J. H. Munoz, R. A. Jacob, L. M. Klevay, S. J. Reck, G. M. Logan, Jr., F. R. Dintzis, G. E. Inglett, and W. C. Shuey. Influence of dietary fiber on trace element balance. Am. J. Clin. Nutr. (in press).

Sandstead, H. H., L. M. Klevay, J. M. Munoz, R. A. Jacob, G. M. Logan, Jr., S. J. Reck, F. R. Dintzis, G. E. Inglett, and W. C. Shuey. Zinc requirements. Proceedings of Symposium on Trace Elements in Human Nutrition, Bad Kissingen, West Germany, November 24, 1977.

Beltsville, Maryland

Hargrove, R. E. and J. A. Alford. Growth rate and feed efficiency of rats fed yogurt and other fermented milks. J. Dairy Sci. 60:11-19. 1978.

Li, B. W., T. W. Cochran, and J. R. Vercellotti. Chemical ionizations mass spectra of per-o-acetyl-alDONONITRILES and methylated alDONONITRILE acetates. Carbohydrate Res. 59:567-570. 1977.

Mertz, W., R. W. Anderson, and W. R. Wolf. Progress of chromium nutrition research. Third International Symposium on Trace Element Metabolism in Man and Animals, Freising-WeiHenstephan, West Germany. In press. 1977.

Punsar, S., W. Wolf, W. Mertz, and M. J. Karvonene. Urinary chromium excretion and atherosclerotic manifestations in two Finnish male populations. Annals of Clinical Research 9:79-83. 1977.

Rook, H. L. and W. R. Wolf. The quantitative determination of volatile trace elements in NBS biological Standard Reference Material 1569, Brewer's Yeast. Proceedings 11th Trace Substances Conference, Columbia, Mo. In press. 1977.

Stewart, K. K. A simple system for depulsing positive displacement pumps. Analytical Chemistry 49:2125-2126. 1977.

Stewart, K. K. Thin film dialysis. In: "Advances in Protein Chemistry" (Edited by C. B. Anfinsen, J. T. Edsall, and F. M. Richards). Vol. 31, pp. 135-186. 1977.

Stewart, K. K., G. R. Beecher, P. E. Hare. United States Patent, 4,013,413, Apparatus and Method for Rapid Analyses of Plurality of Samples. 1977.

Toepfer, E. W., W., Mertz, M. M. Polansky, E. E. Roginski, and W. R. Wolf. Preparation of chromium containing material of glucose tolerance factor activity from Brewer's yeast extracts and by synthesis. J. Agric. and Food Chem. 25:162-166. 1977.

Wolf, W. R. Trace element composition of foods: Analytical needs and problems. Analytical Chemistry 50:190A-194A. 1978.

Wolf, W. R. Trace element content of wheat base-line study. Proceeding of Tenth National Conference on Wheat Utilization Research. In press. 1977.

Wolf, W. R. Coupled gass chromatography - atomic absorption spectrometry. J. Chrom. 134:159-165. 1977.

Wong, N. P., D. E. LaCroix, and J. H. Vestal. Trace minerals in cottage cheese. J. Dairy Sci. 60:1650. 1977.

Wong, N. P., D. E. LaCroix, J. H. Vestal, and J. A. Alford. Composition of cheddar cheese made with different milk clotting enzymes. J. Dairy Sci. 60:1522. 1977.

#### Hyattsville, Maryland

Adams, C. F. and M. Richardson. Nutritive value of foods (rev.), U.S. Dept. Agr., Home and Gard. Bul. No. 72, 44 pp. 1977.

Anderson, B. A. Comprehensive evaluation of fatty acids in foods. XIII. Sausages and luncheon meats. Amer. Dietet. Assoc. Jour. 72(1):48-52.

Anderson, B. A., G. A. Fristrom, and J. L. Weihrauch. Comprehensive evaluation of fatty acids in foods. X. Lamb and veal. Amer. Dietet. Assoc. Jour. 70(1):53-58. 1977.

Consumer and Food Economics Institute. Composition of foods...spices and herbs...raw, processed, prepared. U.S. Dept. Agr., Agr. Handb. 8-2. 1977.

Exler, J. and J. L. Weihrauch. Comprehensive evaluation of fatty acids in foods. XII. Shellfish. Amer. Dietet. Assoc. Jour. 71(5):518-521. 1977.

Exler, J., R. M. Avena, and J. L. Weihrauch. Comprehensive evaluation of fatty acids in foods. XI. Leguminous seeds. Amer. Dietet. Assoc. Jour. 71(4):412-415. 1977.

Gebhardt, S. E., E. R. Elkins, Jr., J. Humphrey. Comparison of two methods used for determining the vitamin A value of clingstone peaches. Jour. Agr. and Food Chem. 25(3):629-632. 1977.

Kinsella, J. E., J. L. Shimp, J. Mai, and J. Weihrauch. Fatty acid content and composition of freshwater finfish. Amer. Oil Chem. Soc. Jour. 54(10):424-429. 1977.

Kinsella, J. E., J. L. Shimp, J. Mai, and J. Weihrauch. Sterol phospholipid, mineral content, and proximate composition of selected freshwater species. Jour. Food Biochem. 1(1):131-140. 1977.



Matthews, R. H. and M. Y. Workman. Nutrient content of selected baby foods. Amer. Dietet. Assoc. Jour. 72(1):27-30. 1978.

Matthews, R. H. and M. Y. Workman. Nutrient composition of selected wheat products. Cereal Chem. 54(5):1115-1123. 1977.

Rizek, R. L. and L. P. Posati. Revision of Agriculture Handbook No. 8. Nutr. News 40:9, 12. 1977.

Sweeney, J. P. and J. L. Weihrauch. Summary of available data for cholesterol in foods and methods for its determination. Crit. Rev. in Food Sci. and Nutr. 8(2):131-159. 1977.

Watt, B. K. and L. P. Posati. Food supply and consumption patterns: Food consumption data. In: "Nutrition and Coronary Heart Disease" (Edited by R. I. Levi, B. M. Rifkind, B. H. Dennis, and N. D. Ernst) Raven Press, New York. In press. 1977.

Weihrauch, J. L. Invited book review of "Lipid Chromatographic Analysis" Vol. 3, 2nd ed., G. V. Marinetti, ed. Food Technol. 31(4):128-129. 1977.

Weihrauch, J. L. and J. Gardner. Phytosterol content of foods. Abstract for presentation at the Annual Meeting of the AOCS in May 1977. Amer. Oil Chem. Soc. Jour. 54(2):144 (Abstract 203). 1977.

Weihrauch, J. L. and R. H. Matthews. Lipid content of selected cereal grains and their milled and baked products. Cereal Chem. 54(3):444-453. 1977.

Weihrauch, J. L., L. P. Posati, B. A. Anderson, and J. Exler. Lipid conversion factors for calculating fatty acid content of foods. Amer. Oil Chem. Soc. Jour. 54(1):36-40.

Weihrauch, J. L., C. A. Brignoli, J. B. Reeves, III, and J. L. Iverson. Fatty acid composition of margarines, processed fats, and oils: A new compilation of data for tables of food composition. Food Technol. 31(2):80-85. 1977.

#### Philadelphia, Pennsylvania

Goering, H. K., T. R. Wrenn, L. F. Edmondson, J. R. Weyant, D. L. Wood, and J. Bitman. Feeding polyunsaturated vegetable oils to lactating cows. J. Dairy Sci. 60:739-748. 1977.

Holsinger, V. H., Y. Hafez, and P. M. T. Hansen. Effect of ammoniated casein in the diet on the growth of weanling rats. J. Agric. Food Chem. 25:1109-1111. 1977.

Holsinger, V. H., C. S. Sutton, H. E. Vettel, C. Allen, and F. B. Talley. Acceptability of whey-soy drink mix prepared with cottage cheese whey. J. Dairy Sci. 60:1841-1845. 1977.

Wrenn, T. R., J. Bitman, J. R. Weyant, D. L. Wood, K. D. Wiggers, and L. F. Edmondson. Milk and tissue lipid composition after feeding cows protected polyunsaturated fat for two years. J. Dairy Sci. 60:521-532. 1977.

TO 2

Albany, California

Betschart, A. A. Separation of protein isolates from safflower seeds. U.S. Patent No.: 4,072,669. 1977.

Saunders, R. M. and A. A. Betschart. Protein quality of wheat millfeed protein concentrates. J. Food Sci. 42:974-975, 981. 1977.

ANNUAL REPORT  
FY 1977

National Research Program 20910

HUMAN REQUIREMENTS FOR NUTRIENTS

This National Research Program is one of three major programs that constitute the research effort in the USDA's mission in food and nutrition. Its objectives are the identification of all nutrients essential for man and the exact quantitative definition of the human requirements, by sex and age groups, for maintenance of optimal health. The program is complemented by NRP 20900, dealing with food composition and technology of food improvement, and by NRP 20920, covering food consumption, education and food use. There is also an interaction with parts of NRP 20780 on managing soil fertility for increased nutritional quality of plants and animals. The totality meets the operating goal of food and nutrition research and information services.

NPS Contact: (J. M. Iacono, Interim)

PACS Contact: C. Golumbic

Technological Objective 1:

Determine the requirements for lipid intake and identification of the forms of these nutrients in foods that may be useful in meeting these requirements.

Research Locations:

Peoria, Illinois  
Beltsville, Maryland

Selected Examples of Progress:

The tocopherol (vitamin E) content of platelets reflects levels in muscle, testes and other tissues, and thus may provide an easily evaluated index of vitamin E nutritional status - Beltsville, MD. Serum analysis, currently used as an index of vitamin E status, is unreliable since the highly variable serum lipid content causes changes in tocopherol which are not reflected in the tissues.

A new technique, the measurement of retinal arteriole size by computer controlled image dissection of photographic color transparencies of the retina has been successfully used as a means for assessing dietary effects on hypertension and arteriole size - Beltsville, MD. Hypertension is thought to adversely affect the small blood vessels in critical areas such as the brain, leading to strokes and other catastrophic effects. This technique will allow non-invasive measurement of the effects of diet on both blood pressure and small blood vessels.



Epidemiological studies on diet and thrombosis performed in three countries indicate that in humans, as has been shown in animals, diets high in saturated fats (Nurmijarvi, Finland) may predispose to thrombosis in man - Beltsville, MD. This effect appears to be decreased by eating diets lower in saturated fats as in Canino, Italy, or by reduction of saturated fats along with an increase in polyunsaturated fats, as in the diet in Beltsville, Maryland, U.S.A., subjects.

Deuterium for Synthesizing Fats - Peoria, IL. Techniques have been discovered for synthesizing fats "tagged" with deuterium. Deuterium, commonly called heavy hydrogen, is safe, stable, nontoxic, and nonradioactive. When deuterium is used to replace normal hydrogen in fats, it serves as the ideal tag for following fat metabolism in people. These deuterium labeled fats can be safely fed to normal healthy men, women, and children in order to investigate fat metabolism. Previously, only toxic radioactively labeled fats were available for tracer work, and they could only be fed to people at very low levels. These synthetic achievements provide a means for nutritionists, biochemists, and medical researchers to have access to labeled fats which are uniquely suited for nutritional and metabolic studies in people. (Contact H. J. Dutton, OC.)

#### Technological Objective 2:

Determine the requirements for mineral intake by humans and identification of the forms of these nutrients in foods that may be useful in meeting these requirements.

#### Research Locations:

Beltsville, Maryland  
Ithaca, New York  
Grand Forks, North Dakota

#### Selected Examples of Progress:

Cobalt may have a biological function in rats - Beltsville, MD. Growth effects have been observed with very low levels of cobalt, in the presence of adequate amounts of vitamin B<sub>12</sub>.

Phytate extraction of bran increases the bioavailability of iron and zinc - Beltsville, MD.

Synthetic chromium containing Glucose Tolerance Factors binds to insulin - Beltsville, MD. Synthetic GTF has been shown to bind to insulin, similar to natural GTF from yeast. This finding increases our understanding of its mode of action.

Multiple nutritional deficiencies increase lead toxicity - Beltsville, MD. Lead poisoning is much more severe in rats deficient in both calcium and vitamin E than in rats deficient in either nutrient alone. This potentiation of lead toxicity by a combination of nutritional deficiencies indicates the need to assess the effects of exposure to heavy metal environmental pollutants in individuals suffering from several simultaneous marginal deficiencies.

Novel lesion in iron deficiency clarified - Beltsville, MD. Red blood cells from iron-deficient rats lose their ability to deform when placed under mechanical stress. This impaired deformability may account for the decreased life span of such red cells and may contribute to the anemia seen in iron deficiency.

Development of Reliable Analytical Techniques for Quantitative Determination of Stable Iron Isotopes - Ithaca, NY. Techniques for preparation and extraction of volatile chelates of stable iron isotopes has been accomplished. The development of these techniques will make it possible to study iron absorption and utilization in human subjects without exposing them to ionizing radiation.

Development of a Defined System for Induction of Zinc Deficiency in Pregnant Rats - Ithaca, NY. A method for inducing zinc deficiency in pregnant rats has been worked out. The amount of zinc required for parturition and the time at which zinc has its greatest effect has been determined. Studies of the mechanisms involved in the decrease in blood volume that occurs in zinc-deficient, pregnant rats may have significant implications for pregnant women since decreased blood volume contributes to the severity of the eclampsia of pregnancy.

Intrauterine zinc deficiency causes increased aggression in rehabilitated offspring - Grand Forks, ND. This was associated with depressed development of specific areas of the brain.

Patients with sickle cell anemia, cystic fibrosis and anorexia nervosa have low plasma zinc levels - Grand Forks, ND. This suggests that marginal zinc intake may be a complicating factor in these diseases.

Copper and zinc requirement determined in human volunteers - Grand Forks, ND. The minimal requirement for these two essential elements was: Zn, 12.4 mg/day, and Cu, 1.3 mg/day. This requirement was not affected by dietary bran.

Arsenic deficiency was induced in chicks - Grand Forks, ND. These results are strongly indicative of an essential role of this element.

Extrinsic label can be used to measure biological availability of zinc in rats - Grand Forks, ND. This method, if applicable in humans, will greatly facilitate the determination of bioavailable zinc.

### Technological Objective 3:

Determine the requirements for vitamin intake by humans and identification of the forms of these nutrients in foods that may be useful in meeting these requirements.

### Research Locations:

Beltsville, Maryland

Selected Examples of Progress:

Vitamin E deficiency and lead poisoning accentuate damage to red blood cells by industrial chemical in vitamin E deficiency - Beltsville, MD. Methylhydrazine injured red cells from vitamin E-deficient rats and lead poisoning intensified this effect. Methylhydrazine finds many industrial uses such as rocket fuel in the space program and workers overexposed to this chemical suffer increased red cell. Investigation of any possible prophylactic benefit of vitamin E in such situations is warranted.

Lead poisoning accelerates aging of red blood cells in vitamin E deficiency - Beltsville, MD. Separation of red blood cells from lead-poisoned vitamin E-deficient rats into young and old populations according to cell age revealed that the old cells cannot flow through narrow passageways. This physical defect in old red cells may help explain the cause of anemia in lead poisoning.

Technological Objective 4:

Determine the requirements for protein and amino acid intake by humans and identification of the forms of these nutrients in foods that may be useful in meeting these requirements.

Research Locations:

Beltsville, Maryland

Selected Examples of Progress:

Small for terms babies can be predicted from amino acid pattern of mother at 25th week of pregnancy - Beltsville, MD. Continuing work has confirmed the initial observations and promises a useful tool to diagnose those at risk.

Sulfate excretion and selected blood amino acid values may be useful indicators of protein nutritive value to man - Beltsville, MD.

Feeding superadequate dietary protein to rats results in increased amino acid catabolism and decreased collagen biosynthesis - Beltsville, MD. A majority of humans in the United States ingest two to three times the Recommended Dietary Allowance (RDA) of protein. Experiments with rats demonstrated that when they were fed 2-3 times the RDA for protein, a considerable amount of energy was derived from the "excessive" dietary protein. At the same time, biosynthesis of one of the most important proteins in the body, collagen, was drastically decreased. These observations suggest that, at least in one specie of laboratory animals, ingestion of more than the RDA of protein results in a marked alteration in the metabolism on one of the most abundant proteins in the body. In addition, energy is derived from a very expensive source, protein.



Technological Objective 5:

Determine the requirements for carbohydrate and energy intake in humans and identification of the forms of these nutrients in foods that may be useful in meeting these requirements.

Research Locations:

Beltsville, Maryland  
Grand Forks, North Dakota

Selected Examples of Progress:

Consumption of fresh fruit and vegetables increased fecal weight and transit time in human subjects - Beltsville, MD. It also lowered diastolic blood pressure in those entering the study with pressures greater than 80 mm.

Some sources of dietary fiber improve glucose tolerance, others lower serum cholesterol in human subjects - Grand Forks, ND. Corn bran, soybean hulls, apple powder and carrot powder improved glucose metabolism; hard red spring wheat bran and soybean hulls lowered cholesterol significantly, when added to a conventional diet.

Sucrose consumption increases measured health risk factor - Beltsville, MD. Measurable factors associated with risk of heart disease and diabetes were increased when human volunteers were fed nutritionally complete diets containing sucrose instead of starch. The level of sucrose used in the 6-week study was only slightly higher than that believed to be presently consumed in the United States.

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This Annual Report was prepared by Walter Mertz, Nutrition Institute, Beltsville, Maryland.

PUBLICATIONS

TO 1

Peoria, Illinois

Adlof, R. O. and E. A. Emken. Improved synthesis of methyl cis-9-octadecenoate-d<sub>6</sub>. Accepted for publication in J. Labeled Compd. Pharm., August 1977.

Adlof, R. O., W. E. Neff, E. A. Emken, and E. H. Pryde. Preparation and selective hydrolysis of acetal esters. J. Am. Oil Chem. Soc. 54:414-416. 1977.

Emken, E. A. Commercial and potential utilization of soybean lipoxxygenase. Accepted for publication in J. Am. Oil Chem. Soc., November 1977.

Emken, E. A., J. C. Hartman, and C. R. Turner. Separation of octadecadienoate, octadecatrienoate and acetylenic fatty acids by silver resin chromatography. Accepted for publication by J. Am. Oil Chem. Soc., August 1977.

Rakoff, H. and E. A. Emken. Silver-resin chromatographic separation of cis and trans- mono- and dihydroxy fatty esters. Accepted for publication by J. Am. Oil Chem. Soc., November 2, 1977.

Rakoff, H. and E. A. Emken. Stereospecific synthesis of cis and trans fatty esters. Lipids 12:760-761. 1977.

Lanser, A. C., T. L. Mounts, and E. A. Emken. Metabolism of linoleate versus linoelaidate in the laying hen. Accepted for publication in Lipids, October 1977.

Beltsville, Maryland

Ferretti, A. and V. P. Planagan. Tissue variation in hydrocarbon composition in the rabbit. Lipids 12:198-203. 1977.

Lehmann, J., N. W. Schoene, and J. P. Church. Essential fatty acid deficiency and platelet fatty acids of normotensive and genetically hypertensive rats. Prostaglandins 13:583-586. 1977.

Lehmann, J., M. W. Marshall, H. T. Slover, and J. M. Iacono. Influence of dietary fat level and dietary tocopherol on plasma tocopherol of human subjects. J. of Nutr. 107:1006-1015. 1977.

Schoene, N. W. Properties of platelet phospholipase A<sub>2</sub>. Advances in Prostaglandin and Thromboxane Research, Vol. 3 (Edited by C. Galli, et al.) Raven Press, New York, pp. 121-125. 1977.

TO 2

Beltsville, Maryland

Anderson, R. A. and W. Mertz. Glucose tolerance factor: An essential dietary agent. Trends in Biochem. Sciences 2:277-279. 1977.

Anderson, R. A. and B. L. Vallee. Selective cobalt oxidation as a means to differentiate metal-binding sites of cobalt alkaline phosphatase. Biochem. 16:4388-4393. 1977.

Atsuya, I., G. M., Alter, C. Veillon, and B. L. Vallee. Low-pressure microwave - induced plasma emission spectrometry method for the determination of nanogram quantities of arsenic in monoarsanilazo try-248 carboxypeptidase. Anal. Biochem. 79:202. 1977.

Atsuya, I., H. Kawaguchi, C. Veillon, and B. L. Vallee. 1977. Enhancement of emission by potassium chloride in the low-pressure microwave-induced plasma emission spectrometer. Anal. Chem. 49:1489. 1977.

Bosron, W. F., R. A. Anderson, M. C. Falk, F. S. Kennedy, and B. L. Vallee. Effect of magnesium on the properties of zinc alkaline phosphatase. Biochem. 16:610-614. 1977.

Ellis, R., E. R. Morris, and C. Philpot. Quantitative determination of phytate in the presence of high inorganic phosphate. Anal. Biochem. 77:536-539. 1977.

Mertz, W. Criteria for adequacy and safety of trace elements in animal nutrition. J. Animal Sci. 40(3):469-474. 1977.

Mertz, W. Fortification of foods with vitamins and minerals. In: "Food and Nutrition in Health and Disease," Vol. 300. New York Academy of Sciences, New York, N.Y., pp. 151-160. 1977.

Punsar, S., W. Wolf, W. Mertz, and M. J. Karvonen. Urinary chromium excretion and atherosclerotic manifestations in two Finnish male populations. Annals of Clin. Res. 9:79-83. 1977.

Roginski, E. E. and W. Mertz. A biphasic response of rats to cobalt. J. Nutr. 107(8):1537-1542. 1977.

Toepfer, E. W., W. Mertz, M. M. Polansky, E. E. Roginski, and W. R. Wolf. Preparation of chromium-containing material of glucose tolerance factor activity from Brewer's yeast extracts and by synthesis. J. Agric. Food Chem. 25(1):162-166. 1977.

Mertz, W. Recommended dietary allowances for minerals: Problems and progress. Proceedings of 11th Annual Conference on Trace Substances in Environmental Health, in Columbia, MO. 1977.



Allaway, W. H., O. A. Levander, G. Matrone, and H. H. Sandstead. Interactions of trace elements. In: "Geochemistry and the Environment," Vol. II. National Research Council, National Academy of Sciences, Washington, D.C., pp. 111-115. 1977.

Levander, O. A. Nutritional factors in relation to heavy metal toxicants. Fed. Proc. 36:1683-1687. 1977.

Levander, O. A. Metabolic interrelationships between arsenic and selenium. Environ. Health Perspec. 19:159-164. 1977.

Levander, O. A. Selenium in foods. In: "Selenium-Tellurium in the Environment. pp. 26-53. 1976.

Levander, O. A. Biologic effects of arsenic on plants and animals - laboratory animals. In: "Arsenic, Committee on Biologic Effects of Environmental Pollutants, National Research Council, National Academy of Sciences, Washington, D.C., pp. 128-144. 1977.

Levander, O. A., R. J. Ferretti, and V. C. Morris. Osmotic and peroxidative fragilities of erythrocytes from vitamin E-deficient lead-poisoned rats. J. Nutr. 107:373-377. 1977.

Levander, O. A., M. Fisher, V. C. Morris, and R. J. Ferretti. Morphology of erythrocytes from vitamin E-deficient lead-poisoned rats. J. Nutr. 107:1828-1836. 1977.

Levander, O. A., V. C. Morris, R. J. Ferretti. Interactions of lead poisoning and vitamin E deficiency. Clin. Chem. and Chem. Tox. of Metals 1:23-26. 1977.

Levander, O. A., V. C. Morris, R. J. Ferretti. Filterability of erythrocytes from vitamin E-deficient lead-poisoned rats. J. Nutr. 107:363-372. 1977.

Levander, O. A., V. C. Morris, and R. J. Ferretti. Comparative effects of selenium and vitamin E in lead-poisoned rats. J. Nutr. 107:378-382. 1977.

Levander, O. A., V. C. Morris, and R. J. Ferretti. Effect of oxidants, hydrazines, and aminoquinolines on the filterability of erythrocytes from vitamin E-deficient lead-poisoned rats. J. Nutr. 107:2135-2143. 1977.

#### Ithaca, New York

Apgar, J. Use of EDTA to produce zinc deficiency in the pregnant rat. J. Nutr. 107:539-545. 1977.

Apgar, J. Mobilization of vitamin A by zinc-deficient female rat. Nutr. Rep. Internat. 15:553-559. 1977.

Apgar, J. Effects of zinc deficiency and zinc repletion during pregnancy on parturition in two strains of rats. J. Nutr. 107:1399-1402. 1977.

Everett, G. A. and J. Apgar. Urinary taurine, sulfate and urea as possible indicators of zinc status in the rat. Nutr. Rep. Internat. 16:391-396. 1977.

Apgar, J. Effect of zinc repletion for limited times on parturition in rats. In: "Trace Element Metabolism in Man and Animals - 3". (Edited by M. Kirchgessner) ATW Publishers, Freising-Weihenstephan, Germany, pp. 436-439. 1978.

House, W. A., R. M. Welch, and D. R. Van Campen. Zinc kinetics and metabolism in rats fed diets with or without phytic acid. In: "Trace Element Metabolism in Man and Animals - 3". (Edited by M. Kirchgessner) ATW Publishers, Freising-Weihenstephan, Germany, pp. 171-174. 1978.

Van Campen, D. R. and L. F. Hood. Dietary carbohydrates and mineral nutrition. In: "Carbohydrates and Health" (Edited by L. F. Hood, et al.) Avi Publishing Co. 1977.

#### Grand Forks, North Dakota

Allen, K. G. D., L. M. Klevay, and H. L. Springer. The zinc and copper content of seeds and nuts. Nutrition Reports International 16:227-230. 1977.

Buell, S. J., G. J. Fosmire, D. A. Ollerich, and H. H. Sandstead. Effects of postnatal zinc deficiency on cerebellar and hippocampal development in the rat. Experimental Neurology 55:199-210. 1977.

Crosby, W., J. Metcuff, P. Costiloe, M. Mameesh, H. Sandstead, R. Jacob, P. McClain, G. Jacobson, W. Reid, and G. Burns. Fetal malnutrition: An appraisal of correlated factors. Am. J. Obstet. Gynecol. 128:22-31. 1977.

Duerre, J. A., K. M. Ford, and H. H. Sandstead. Effect of zinc deficiency on protein synthesis in brain and liver of suckling rats. J. Nutr. 107:1082-1093. 1977.

Evans, G. W. Metabolic disorders of copper metabolism. In: "Advances in Nutritional Research-I". (Edited by H. H. Draper) Plenum Publishing Corp., New York, pp. 167-187. 1977.

Evans, G. W. New aspects of the biochemistry and metabolism of copper. In: "Zinc and Copper in Clinical Medicine". (Edited by K. M. Hambidge and B. L. Nichols) Spectrum, Jamaica, New York, pp. 113-118. 1977.

- Evans, G. W. and P. E. Johnson. Determination of zinc availability in foods by the extrinsic label technique. *Am. J. Clin. Nutr.* 30: 873-878. 1977.
- Evans, G. W., R. S. Pekarek, K. G. D. Allen, and P. E. Johnson. Anemia infection or bioavailable copper. (Letter) *Am. J. Clin. Nutr.*, 30: 654-655. 1977.
- Fosmire, G. J., S. Greeley, and H. H. Sandstead. Maternal and fetal response to various suboptimal levels of zinc intake during gestation in the rat. *J. Nutr.* 107:1543-1550. 1977.
- Foxmire, G. J. and H. H. Sandstead. Effects of zinc deficiency on compositional development and protein synthesis in liver, heart, and kidney of the suckling rat. *Proc. Soc. Exp. Biol. Med.* 154:351-355. 1977.
- Halas, E., G. Reynolds, M. Rowe, M. Heinrich, and M. Pirc. Comparison of frequency, intensity, and duration of aggressive responses in rats. *Physiology & Behavior* 18:975-977. 1977.
- Halas, E. S., G. M. Reynolds, and H. H. Sandstead. Intra-uterine nutrition and its effects on aggression. *Physiology & Behavior* 19: 653-661. 1977.
- Hopkins, L. L., Jr., H. L. Cannon, A. T. Miesch, R. M. Welch, and F. H. Nielsen. Vanadium. In: "Geochemistry and the Environment-2". (Edited by M. Y. Duggan) National Academy of Sciences, Washington, D.C., pp. 93-107. 1977.
- Jacob, R. A., L. G. Baesler, L. M. Klevay, D. E. Lee, and P. L. Wherry. Hypercholesterolemia in mice with meat anemia. *Nutr. Rep. Intern.* 16:73-79. 1977.
- Johnson, P. E. and G. W. Evans. Coffee as a low-calorie vehicle for iron-fortification. *Nutr. Rep. Intern.* 16:89-92. 1977.
- Johnson, P. E., C. Straus, and G. W. Evans. Metallocalorie ratios for copper, iron, and zinc in fruits and vegetables. *Nutr. Rep. Intern.* 15:469-475. 1977.
- Klevay, L. M. Elements of ischemic heart disease. *Perspectives in Biology and Medicine* 20:186-192. 1977.
- Klevay, L. M. Hypocholesterolemia due to sodium phytate. *Nutr. Rep. Intern.* 15:587-595. 1977.
- Klevay, L. M. Importance of the zinc-to-copper ratio of the diet. *Nutrition & the M.D.* 3:1. 1977.



Klevay, L. M. Ischemic heart disease: The fiber hypothesis. Proceedings of the Miles Symposium, sponsored by the Nutrition Society of Canada, pp. 33-39. 1977.

Klevay, L. M. The role of copper and zinc in cholesterol metabolism. In: "Advances in Nutritional Research-I". (Edited by H. H. Draper) Plenum Publishing Corp., New York, pp. 227-252. 1977.

Klevay, L. M. and K. G. D. Allen. Vitamin B6, copper, and atherosclerosis. (letter) The Lancet i:1209. 1977.

Myron, D. R., S. H. Givand, and F. H. Nielsen. Vanadium content of selected foods as determined by flameless atomic absorption spectroscopy. J. Agricultural and Food Chemistry 25:297-300. 1977.

Nielsen, F. H. Newer trace elements and possible application to man. In: "Trace Elements in Human Health and Disease-2" (Edited by A. S. Prasad) Academic Press, New York, pp. 379-399. 1976.

Nielsen, F. H. Nickel toxicity. In: "Toxicology of Trace Elements" (Edited by R. A. Goyer and M. A. Mehlman) Hemisphere Publishing Corp., Washington, D.C., pp. 129-146. 1977.

Nielsen, F. H., H. T. Reno, L. O. Tiffin, and R. M. Welch. Nickel. In: "Geochemistry and the Environment-2" (Edited by M. Y. Duggan) National Academy of Sciences, Washington, pp. 40-53, 1977.

Pekarek, R. S., A. M. Hoagland, and M. C. Powanda. Humoral and cellular immune responses in zinc deficient rats. Nutrition Reports International 16:267-276. 1977.

Reis, B. L. and G. W. Evans. Genetic influence on zinc metabolism in mice. J. Nutr. 107:1683-1686. 1977.

Sandstead, H. H. Nutrient interactions with toxic elements. In: "Toxicology of Trace Elements" (Edited by R. A. Goyer and M. A. Mehlman) Hemisphere Publishing Corp., Washington, D.C., pp. 241-256. 1977.

Sandstead, H. H., G. J. Fosmire, E. S. Halas, R. A. Jacob, D. A. Strobel, and E. O. Marks. Zinc deficiency: Effects on brain and behavior of rats and Rhesus monkeys. Teratology 16:229-234. 1977.

Solomons, N. W., I. H. Rosenberg, H. H. Sandstead, and K. P. Vo-Khactu. Zinc deficiency in Crohn's Disease. Digestion 16:87-95. 1977.

TO 3

Beltsville, Maryland

Reynolds, R. D. Vitamin B<sub>6</sub> requirement for irreversible inactivation of rat liver tyrosine aminotransferase. Arch. Biochem. Biophys. In Press.

TO 4

Beltsville, Maryland

Crosby, W. M., J. Metcuff, J. P. Costiloe, M. Mameesh, H. H. Sandstead, R. A. Jacob, P. E. McClain, G. Jacobson, W. Reid, and G. Burns. Fetal malnutrition: An appraisal of correlated factors. Am. J. Ob. Gyn. 128:22-31. 1977.

Dohm, G. L., G. R. Beecher, T. P. Stephenson, and M. Womack. Adaptations to endurance training at three intensities of exercise. J. Appl. Physiol.: Respirat. Environ. Exercise Physiol. 42:753-757. 1977.

Dohm, G. L., H. A. Barakat, E. B. Tapscott, and G. R. Beecher. Changes in body fat and lipogenic enzyme activities in rats after termination of exercise training. Proc. Soc. Expt. Biol. Med. 155: 157-159. (1977).

Dohm, G. L., A. H. Hecker, W. E. Brown, G. J. Klain, F. R. Puente, E. W. Askey, and G. R. Beecher. Adaptation of protein metabolism to endurance training. Biochem. J. 164:705-708. 1977.

Dohm, G. L., G. R. Beecher, A. L. Hecker, F. R. Puente, G. J. Klain, and E. W. Askey. Changes in protein synthesis in rats in response to endurance training. Life Sciences 21:189-198. 1977.

Hackler, L. R. Methods of measuring protein quality: A review of bioassay procedures. Cereal Chem. 54:984-995. 1977.

Lipton, S. H., C. E. Bodwell, and A. H. Coleman, Jr. Amino acid analyzer studies of the products of peroxide oxidation of cystine, lanthionine and homocystine. J. Agric. Food Chem. 25:624-628. 1977.

Lipton, S. H., and C. E. Bodwell. A rapid method for detecting chemical alteration of methionine. J. Agric. Food Chem. 25:1214-1216. 1977.

McClain, P. E. Chemistry of collagen crosslinking. Proc. 29th Ann. Recip. Meat Conf. of AMSA (Conference Proceedings), pp. 350-374. 1977.

McClain, P. E. Chemistry of collagen crosslinking: Relationship to aging and nutrition. In: "Protein Crosslinking: Nutrition and Medical Consequences" (Edited by M. Friedman) Plenum, N. Y. pp. 603-618. 1977.

McClain, P. E., E. R. Wiley, P. R. Reynolds, and S. C. Morris. Isolation and characterization of papain solubilized collagen from bovine spinous process cartilage. *Int. J. Biochem.* 8:381-387. 1977.

McClain, P. E. and E. R. Wiley. Changes in the biosynthesis and crosslinking of rat skin collagen during inanition. *Nutr. Reports Int.* 16:377-382. 1977.

Ngo, A., C. N. Coon, and G. R. Beecher. Dietary glycine requirements for growth and cellular development in chicks. *J. Nutr.* 107:1800-1808. 1977.

Rampton, J. H., A. M. Pearson, J. E. Walker, J. G. Kapsalis, and C. E. Bodwell. Urea-disc-electrophoresis of actin, tropomyosin, troponin,  $\alpha$ -actinin,  $\beta$ -actinin, and the extra protein fraction from striated muscle. *Food Chem.* 2:7-18. 1977.

Bodwell, C. E. "Evaluation of Proteins," Editor, Avi Publishing Co., Inc., Westport, Conn. 1977.

Bodwell, C. E. Biochemical indices in humans. In: "Evaluation of Proteins for Humans," (Edited by C. E. Bodwell) Avi Publishing Co., Westport, Conn., pp. 119-148. 1977.

Bodwell, C. E. Use of enzymatic assays for the determination of nutritional quality. In: "Nutritional Evaluation of Cereal Mutants" (Inter. Atomic Energy Agency, Vienna, Austria. pp. 87-105. 1977.

Bodwell, C. E. Problems associated with the development and application of rapid methods of assessing protein quality. *Food Tech.* 31:73-77. *Nutr. Reports Internal.* 16:163-178. 1977.

Bodwell, C. E. The application of animal data to human nutrition: A review. *Cereal Chem.* 54:958-983. 1977.

Bodwell, C. E. and S. H. Lipton. Amino acids. In: "Encyclopedia of Food Science" (Edited by A. H. Johnson and M. S. Peterson) Avi Publishing Co., Inc., Westport, Conn., pp. 22-25. 1978.

Coupain, J. G., R. S. Tyzbir, and G. R. Beecher. Influence of altering dietary protein levels during early development of the rat on the activity of several brain enzymes. *J. Nutr.* 107:1102-1113. 1977.

Tyzbir, R. S., J. G. Coupain, and G. R. Beecher. Influence of dietary protein levels on rat brain enzyme activities during early development. *J. Nutr.* 107:1094-1101. 1977.



Vaughan, D. A., M. Womack, and P. E. McClain. Plasma free amino acid levels in human subjects after meals containing lactalbumin, heated lactalbumin or no protein. *Am. J. Clin. Nutr.* 30:1709-1712. 1977.

Vaughan, D. A. Factors affecting nutritional value: Processing effects. In: "Evaluation of Proteins for Humans" (Edited by C. E. Bodwell) Avi Publishing Co., Inc., Westport, Conn., pp. 255-269. 1977.

TO 5

Beltsville, Maryland

Chang, M. L. W. and M. A. Johnson. Influence of dietary fiber (from soybean flour) on lipid metabolism in rats. *Nutr. Rep. Int.* 16:573-578. 1977.

Gardner, L. B., E. B. Spannhake, M. Keeney, and S. Reiser. Effect of dietary carbohydrate on serum insulin and glucagon in two strains of rats. *Nutr. Rep. Int.* 15:361-366. 1977.

Gardner, L. B., E. B. Spannhake, and S. Reiser. 1977. A strain specific increase in blood glycerol level of the carbohydrate-sensitive BHE rat. *J. Nutr.* 107:1884-1888. 1977.

Kelsay, J. L., K. M. Behall, P. B. Moser, and E. S. Prather. 1977. The effect of kind of carbohydrate in the diet and use of oral contraceptives on metabolism of young women. 1. Blood and urinary lactate, uric acid, and phosphorus. *Am. J. Clin. Nutr.* 30:2016-2022. 1977.

Michaelis, O. E., IV and B. Szepesi. Specificity of the disaccharide effect in the rat. *Nutr. Metab.* 21:329-340. 1977.

Michaelis, O. E., IV, J. G. Hallfrisch, J. D. Putney, D. J. Scholfield, and S. Reiser. Comparison of feeding unrefined and refined starch diets on intestinal uptake and hepatic lipogenic enzymes in the rat. *J. Nutr.* 107:2171-2177. 1977.

Nace, C. S. and B. Szepesi. Independence of glycogen accumulation and glucose-6-phosphate dehydrogenase induction in rat liver. *J. Nutr.* 107:2109-2112. 1977.

Reiser, S. Effect of dietary carbohydrate on intestinal transport, insulin status and hepatic enzyme activity in the rat. In: "Developments in Food Carbohydrates - 1" (Edited by G. G. Birch and R. S. Shallenberger) Applied Science Ltd., London, pp. 113-140. 1977.

Reiser, S. and J. Hallfrisch. Insulin sensitivity and adipose tissue weight of rats fed starch or sucrose diets ad libitum or in meals. *J. Nutr.* 107:147-155. 1977.

Reiser, S. and J. Hallfrisch. Stimulation of neutral amino acid transport by fructose in epithelial cells isolated from rat intestine. J. Nutr. 107:767-774. 1977.

Reiser, S., J. Hallfrisch, J. Putney, and F. Lev. Enhancement of intestinal sugar transport by rats fed sucrose as compared to starch. Nutr. Metab. 20:461-470. 1977.

Szepesi, B. and M. G. Epstein. Metabolic memory: On the nature of the primary stimulus for compensatory growth. Nutr. Rep. Int. 15:51-57. 1977.

Szepesi, B. and M. L. Oney. Dietary restriction, compensatory growth and choice feeding of protein and energy by the growing rat. Nutr. Rep. Int. 16:59-71. 1977.

Szepesi, B. and M. G. Epstein. Effect of repeated food restriction-refeeding on growth rate and weight. Am. J. Clin. Nutr. 30:1692-1702. 1977.

Trout, D. L., E. S. Conway, and J. D. Putney. Dietary influences on gastric emptying of carbohydrate versus fat in the rat. J. Nutr. 107:104-111. 1977.

## National Research Program 20920

### FOOD CONSUMPTION AND USE

This National Research Program involves research in food consumption at three levels of use of foods--national, household, and individual--and development of knowledge and guidelines to improve food habits, satisfaction with food, and nutritional levels in people's diets. It is one of three programs that constitute the research effort in USDA's mission in food and nutrition. The programs dealing with food composition and the technology of food improvement are in NRP 20900. Those covering human requirements for nutrients are in NRP 20910. The totality meets the operating goal of food and nutrition research and information sources.

NPS Contact: (J. M. Iacono, Interim)      PACS Contact: C. Golumbic

#### Technological Objective 1:

To provide accurate, up-to-date, and comprehensive information in a readily usable form on food consumption and dietary levels.

#### Research Locations:

Hyattsville, Maryland

#### Selected Examples of Recent Progress:

1977-78 Nationwide Food Consumption and Supplemental Surveys carried out - Hyattsville, MD. During 1977, available resources were concentrated on providing technical support and supervision for nationwide surveys of household food consumption and food intakes of individuals and supplemental surveys in Alaska, Hawaii, and Puerto Rico and among elderly and low-income populations in the 48 States. During January-March, pilot tests were completed, basic survey documents prepared, and 5-day regional training sessions held for interviewers. Since April, information on several thousand additional food items has been developed in handling reportings which reflect expanding variety in the U.S. diet and the new or modified foods now available. Data collection was carried out under contract by the National Analysts Division of Booz, Allen and Hamilton, Inc.

Nationwide Food Consumption Survey. The year-long survey of 15,000 sample households (reporting) in the 48 States began on April 1, 1977. During April-June, 7-day recalls of household food consumption were augmented by 3 days' information on food intakes of all household members. In subsequent quarters, intakes were obtained from all persons 20 years and under and one-half of the adults. By year end, the survey was three-quarters completed.



Bridging Survey. In prior surveys, no advance notice was given. In 1977-78, households were precontacted and requested to keep food notes to help in a 7-day recall. During April-June 1977, information was obtained from 1,464 sample households using 1965-66 procedures to determine changes in 1977-78 results from those of earlier surveys which may be associated with methodological variations.

Elderly Survey. A scheduled year-long supplemental survey of 5,000 sample households with one or more members 65 years and over was initiated on May 1, 1977. Delivery of a list-sample by HEW was delayed pending establishment of a system-of-records under the Privacy Act. The survey was nearly on target by year's end, and projected response levels should be met by March 31, 1978.

Puerto Rican Survey. Prior to initiation of the Puerto Rican survey on July 1, 1977, information on Puerto Rican foods was developed under contract by island food and nutrition experts and survey documents were translated into Spanish. When the survey was terminated on December 31, 1977, information had been obtained from over 3,100 sample households and from approximately 11,700 individuals (all household members). The response rate was above target levels. The variety of local foods reported exceeded expectations, and a major augmentation of technical food information was required.

Alaskan and Hawaiian Surveys. Actions preparatory to initiation of the Alaskan and Hawaiian surveys on January 3, 1978, were completed. The surveys are to be carried out over a 3-month period.

Low-Income Survey. In May 1977, funds were appropriated to cover the costs of a supplemental food consumption survey among low-income households in the 48 States. Plans for the survey were developed in cooperation with the Food and Nutrition Service and a final contract executed with National Analysts in September 1977. Information is to be obtained from 4,100 sample households (and all household members) which were receiving food stamps or which meet income standards for participation. A new probability sampling plan was developed, respondent screening procedures prepared and tested, and a new interviewing staff hired and trained. Data collection began on November 1, 1977, on a 5-month survey to terminate on March 31, 1978.

Further validation of 1977-78 Food Consumption Survey. In March 1977, the Comptroller-General recommended that further validation of food consumption methodology be undertaken. In July 1977, work was initiated by Joseph Steinberg, Survey Design, Inc., to develop a validation plan which would be responsive to the GAO recommendation. In November, Steinberg reported that traditional validation methods were not applicable. A series of partial tests, however, should be undertaken which would narrow the ranges of uncertainty regarding the accuracy of results. Action was initiated to implement the Steinberg recommendations.

Nutritive value of U.S. per capita food supply estimated - Hyattsville, MD. Estimates of the nutritive value of the U.S. per capita food supply beginning with 1909 were updated and an indepth analysis of trends in levels of iron and magnesium carried out. Little change was apparent between 1976 and 1977 in levels of food energy and 14 nutrients routinely reported. Iron levels in 1976 and 1977 are the highest on record. Two main factors accounting for the increase in iron since the mid-1930's are the enrichment and fortification of grain products and a substantial increase in the consumption of meat. The magnesium level has dropped 16 percent since the early 1900's, primarily due to the sharp decline in use of grain products. Nevertheless, the amount available appears to be meeting population needs since a dietary deficiency of magnesium seems to be rare.

#### Technological Objective 2:

To provide consultative assistance on food and nutrition problems and provide sound guidance materials on nutrition, both for the consumer and for nutrition educators, program leaders, and food program managers; to identify techniques which will assist people in selecting nutritionally adequate diets within different budget limitations; to identify means to modify undesirable food habits and to strengthen nutritionally desirable food choices.

#### Research Locations:

Hyattsville, Maryland

#### Selected Examples of Recent Progress:

"Dietary Goals" interpreted - Hyattsville, MD. The Dietary Goals for the United States, proposed by the Senate Select Committee on Nutrition and Human Needs in February 1977, specify levels of fat, fatty acids, cholesterol, total carbohydrate, sugar, and salt that are substantially different from those ordinarily consumed. Diets for men, women, and children, as well as for the population as a whole, were explored using four sets of food options. Most people would need to eat more grain products and vegetables and fruit and less animal fat (from meat and milk), eggs, sugar, and salt than they customarily do to meet the Goals. The magnitude of change in consumption of major groups of foods was estimated. Such estimates are helpful to the Department and others in appraising the Goals.

Aid for precosting food for school food service prepared - Hyattsville, MD. Precosting is a means of identifying foods that can be served economically and predicting total food costs for a meal. An instruction book, "A Guide for Precosting Food for School Food Service," was developed at the request of the Food and Nutrition Service for use by food service managers in the National School Lunch Program (NSLP). The book includes the following information: (1) Menu-planning tips and procedures related specifically to economy; (2) instructions for precosting recipes and individual food items; estimating cost of USDA-donated foods and of condiments, seasonings, and leavenings; precosting the complete menu and menus with choice; and



selecting economical foods; (3) a table showing the decimal equivalents in part of 1 pound, 1 cup, or 1 gallon for different units such as ounces and tablespoons; and (4) a table showing the cost of one serving of food from purchase units providing 1.5 to 240 servings per unit. With the NSLP feeding 26 million children daily, even a small daily saving on food costs for each meal served can have a significant impact on total program costs.

Assistance given on nutrition and nutrition education program and policy problems - Hyattsville, MD. Consultative services and technical assistance provided were greatly expanded over recent years in number of requests honored, in scope of groups aided, and in complexity of assistance desired. Assistance related to nutrition and nutrition education programs and policies was given to groups such as the following: Food and Nutrition Service, SEA-Extension, Agricultural Marketing Service, and Office of Assistant Secretary for Food and Consumer Services, USDA; Technical Assistance Research Programs (a program under contract to the Community Services Administration); Department of Labor; National Institutes of Health; Agency for International Development; Office of Science and Technology Policy; Office of Technology Assessment; House of Representatives' Subcommittee on Domestic Marketing, Consumer Relations, and Nutrition; Senate Select Committee on Nutrition and Human Needs; US-FAO Interagency Committee; Food Marketing Institute; Neilson Organization; National Policy Advisory Committee of the National Science Foundation; Food Policy Committee of the Consumer Federation of America; National Foundation-March of Dimes. Services requested included developing background papers on policy issues, developing nutrition education policy recommendations, specifying changes needed in providing dietary guidance to the public, and providing basic information to support policy decisions.

### Technological Objective 3:

To identify and develop suitable and safe procedures for food management and preparation for home and institutional consumers, for best retention of both nutritional and eating equalities and to avoid food-borne illness.

### Research Locations:

Beltsville, Maryland

### Selected Examples of Recent Progress:

Practices used and spoilage experienced in home canning fruits and vegetables have been identified - Beltsville, MD. The need for both new and experienced home canners to use safe, reliable home-canning instructions was noted in a recent nationwide study. Information from 900 home canners from a national sample of private households in the conterminous U.S. indicated that one out of three U.S. households canned fruit and/or vegetables in 1975. Tomatoes were canned by 75 percent of the canning households; other vegetables, pickles, and fruits were each canned by 50 percent; and about 40 percent preserved jams and jellies. Most home canners were between 25 and 64 years



of age. Two out of five were high school graduates, and about one out of five had some college training. A little more than half were not employed. Total household income was below \$5,000 in 15 percent of the households and over \$20,000 in 10 percent. Friends or relatives were the source of canning instructions for about 60 percent of the canners, while about 40 percent used cookbooks. USDA and State Extension Service publications were each used by about 10 percent of the canners. Three out of four households canned less than 100 quarts of fruits and vegetables, excluding jams and jellies, during the year. Some procedures followed by many home canners are not recommended by USDA, such as packing or filling jars too tightly, reusing flat metal discs from the 2-piece metal lid with band, using paraffin for sealing vegetable and fruit products other than jellies, and using the open-kettle method for canning fruits and vegetables. About one-fourth of the households reported some spoilage of home-canned fruits and vegetables. Three out of four canners believed that the spoilage was due to lids that failed to seal properly, but cause of spoilage was not determined in the study.

Support is given to USDA's food programs - Beltsville, MD. A variety of studies were conducted under a memorandum of understanding with the Food and Nutrition Service (FNS) to provide information about food use in support of the food programs it administers. Students in 4th, 5th, and 6th grades in 24 schools in 6 FNS regions judged the acceptability of 16 USDA standardized recipes developed for the National School Lunch Program. Yield of bean sprouts; canned whole-kernel corn; frozen, cooked battered/breaded chicken parts; frozen beef roasts; frozen pre-formed potato rounds; brown rice; frozen lemon juice concentrate; and frozen cooked turkey rolls was determined. Some of the data along with information provided on use for some items will be used by FNS on fact sheets, specifications, or labels of commodities distributed by USDA to schools and other institutions. Main-dish, salad, cereal, sandwich, vegetable, and dessert items were included in the development and standardization of 18 recipes suitable for 3-6-year-old children in child-care centers. Over 100 recipes were developed or standardized for use in the school lunch program.

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This Annual Report was prepared by Robert L. Rizek, Louise Page, and Robert B. Reese, Consumer and Food Economics Institute, Hyattsville, MD.

SELECTED PUBLICATIONS

Beltsville, Maryland:

Cazier, A., and O. M. Batchner. Food buying guide for child care centers. FNS-108, USDA, 43 pp. Sl. rev. 1977.

Consumer and Food Economics Institute. Apples in appealing ways. HG-161, USDA, 20 pp. Rev. 1977.

Consumer and Food Economics Institute. Pork in family meals. HG-160, USDA, 34 pp. Rev. 1977

Cook, A. Freezing the garden's harvest. Gardening for Food and Fun, Yearbook of Agriculture, USDA:334-339. 1977.

Cook, A., and C. A. Davis. Food preservation glossary. Gardening for Food and Fun, Yearbook of Agriculture, USDA:383-384. 1977.

Davis, C. A. Home canning. Family Economics Review, ARS-NE-36, USDA:7-10. Spring 1977.

Davis, C. A. Home canning of fruits and vegetables. Gardening for Food and Fun, Yearbook of Agriculture, USDA:328-333. 1977.

Davis, C. A., and A. Cook. Questions and answers on home food preservation. Gardening for Food and Fun, Yearbook of Agriculture, USDA:378-382. 1977.

Davis, D. W., and B. K. McGeary. Cooking for two. FNS PA-1043, USDA, 89 pp. Rev. 1977.

Dehydrated instant mashed potatoes (flakes and granules). Unnumbered FNS-USDA release, 2 pp. 1977.

Frozen lemon juice concentrate. Unnumbered FNS-USDA release, 6 pp. 1977.

Fulton, L. H., C. A. Davis, and E. Matthews. Family food buying--a guide for calculating amounts to buy and comparing costs. HERR-37, USDA, 71 pp. Rev. 1977.

Fulton, L. H., E. Matthews, and C. A. Davis. Average weight of a measured cup of various foods. HERR-41, USDA, 26 pp. Rev. 1977.

Serving size and yield for selected fresh vegetables and fruits. Summer Food Service Program for Children Sponsor Handbook. FNS PA-1182, USDA: 89-92. 1977.

Hyattsville, Maryland:

Cost of food at home. Family Economics Review, ARS-NE-36, USDA: Winter 1977, Summer 1977, Fall 1977, 1 p. each; Spring 1977, 5 pp. 1977.



Cost of food at home for a week. Food and Home Notes, OGPA, USDA. Monthly. 1977.

Cost of meats and meat alternates. Food and Home Notes, OGPA, USDA. Quarterly. 1977.

Cost of week's food by family type, June 1977; Cost of one-third of a day's protein, meat and meat alternates, June 1977. 1977 Handbook of Agricultural Charts, USDA:42. 1977.

Cost per month of U.S. Department of Agriculture food plans, U.S. average: 1977 (table 158); Weekly food cost for families by type of family (table 712); and Weekly food cost for families, by cost level and region: 1977 (table 713). Statistical Abstract of the United States: 1977. Bureau of Census, USDC. 1977.

Cromwell, C., and R. L. Kerr. How food dollars were divided, 1965 and 1975. Family Economics Review, ARS-NE-36, USDA:12-16. Summer 1977.

Food consumption: text; 4 charts: Consumption of food energy, protein, fat, and carbohydrate; Consumption of total sugars, refined sugar, starch, and carbohydrate; Sources of sugars; Sources of carbohydrates; and 1 table. 1977 Handbook of Agricultural Charts, AH-524, USDA:52, 53. 1977.

Food for thrifty families. Unnumbered ARS-USDA release, 22 pp. Rev. 1977.

Food nutrients: quantities available for consumption per capita per day, U.S., 1959-76, table 754; and Food nutrients: percentage of total contributed by major food groups, average 1957-59, annual 1976, table 755. Agricultural Statistics, 1977, USDA:561-562. Updated. 1977.

Food plans: food cost at home, at four cost levels, for families and individuals in the United States and for families by region, for 1 week, March 1977 (table 764). Agricultural Statistics, 1977, USDA:562-563. 1977.

Four indexes of civilian per capita food consumption: 1950 to 1976, table 186; Nutrition--nutrients available for civilian consumption per capita per day: 1950 to 1976, table 187; and Nutrition--index of per capita civilian food consumption of selected nutrients: 1940 to 1976, table 188. Statistical Abstract of the United States: 1977. Bureau of Census, USDC: 117, 118. Updated. 1977.

Light, L. Changing times and behaviors. Food Prod. Develop. 11(7):80. 1977.

Marston, R., and B. Friend. Nutritional Review and table: Food consumption per capita per year, by major food groups. CFE(Adm.) 299-11, 11 pp. Reprint from National Food Situation, NFS-158, ERS, USDA, Nov. 1976. 1977.

Nichols, J., P. Rader, and V. Wilkening. A guide for precosting food for school food service. FNS-USDA, PA-1185, 39 pp. 1977.



Peterkin, B. The RDA or U.S. RDA? Jour. Nutr. Ed. 9(1):10-11. 1977.

Peterkin, B., and C. Cromwell. Your money's worth in foods. HG-183, USDA, 28 pp. Rev. 1977.

Peterkin, B., R. L. Kerr, and C. J. Shore. The dietary goals and food on the table. Committee print prepared for the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, 95th Congress, 1st Session:32-53. Dec. 19, 1977.

Raper, N. R. Calcium and phosphorus--dietary concerns. Nutrition Program News, ARS, USDA, 8 pp. Jan.-Apr. 1977.

Walker, M. A., and L. Page. Nutritive content of college meals. III: Minerals. Jour. Amer. Dietet. Assoc. 70:260-266. 1977.





